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Book 3 of 3

The Acoustic Model Evaluation Committee (AMEC) Reports

Volume II, Appendices E-H

The Evaluation of the FACT PL9D Transmission Loss Model (U)

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Appendix IIE. Accuracy Assessment of Generic FACT (Incoherent Phase) Compared to LORAD Experimental Data (U)

LORAD (U)

Environment (U)

(C) The sound speed profile selected for model runs (Martin, 1981) consists of the merge between an average near surface profile (to 150 meters) and a Nansen cast taken about one month after the test. The upper 150 meters of the profiles was the result of averaging 3 bathythermograph records, one at the receiver and two at a distance of one convergence zone (CZ); Sound speeds were originally calculated from equations fit by Mackenzie to tables of Kuwahara. These were later corrected to Wilson's equation. The sound speed is plotted and tabulated in Figure IIE-1. A surface duct is found to a depth of 30.5 meters overlying a deep sound channel with axis at 750 meters. The profile has a positive depth excess of 975 meters and terminates at 5670 meters.

The bottom loss is FNOC Type 5. This is listed in Table IIE-1 and plotted in Figure IIE-2.

Test Cases (U)

(C) Two test cases, each consisting of seven subsets were selected for use in model evaluation and are shown below. The LORAD experimental data for Cases IA through IIG are shown in Figures IIE2 through IIE15.

Accuracy Assessment Results (U)

(C) The accuracy assessment procedures were followed as outlined in section 1.1 and are described in detail in section 5 of volume I of this series. Before proceeding further we must emphasize that in the comparison of the FACT model with LORAD experimental data it is the Generic FACT model (Weinberg, 1980) that was used rather than FACT PL9D which was used for comparison with all other data sets. This choice was motivated by the need for independent selection of start range and range increments for model runs. This was, in turn, required because the LORAD data extends to the seventh convergence zone (CZ), maximum range 440 km and with FACT PL9D, the

Case	Run Number	Frequency (Hz)	Source Depth (m)	Receiver Depth (m)	Bottom Bounce Region	Convergence Zone
IA	35	530	15.2	30.5	First	First
IB	65	530	15.2	30.5	Second	Second
IC	85	530	15.2	30.5	-	Third
ID	105	530	15.2	30.5	-	Fourth
IE	125	530	15.2	30.5	-	Fifth
IF	145	530	15.2	30.5	-	Sixth
IG	165	530	15.2	30.5	-	Seventh
IIA	3D	530	15.2	304.8	First	First
IIB	6D	530	15.2	304.8	Second	Second
IIC	8D	530	15.2	304.8	-	Third
IID	10D	530	15.2	304.8	-	Fourth
IIE	12D	530	15.2	304.8	-	Fifth
IIF	14D	530	15.2	304.8	-	Sixth
IIG	16D	530	15.2	304.8	-	Seventh

spacing between model generated points could be a minimum of 1.76 km over the 440 km range (using the maximum allowable 250 points). This spacing is too gross to capture any CZ structure which might exist. The Generic FACT model, in contrast, does allow independent selection of start range and range increment and was used to generate model points at 0.5 km spacing over the entire range interval. This required three model runs, each generating 300 points (the Generic FACT model does not share the 250 point limitation with FACT PL9D). A few further comments about the use of Generic FACT: Generic FACT is essentially a modularized FACT PL9D run on the UNIVAC 1108 computer. This was done, however, before it was realized that FACT PL9D required some double precision corrections in being transferred from the CDC 6600 to the UNIVAC 1108; The result is that Generic FACT does not have these corrections whereas FACT PL9D as run on the UNIVAC 1108 does. In test cases for physically unrealizable environments significant errors were found in the FACT predictions, necessitating the double precision corrections. Running FACT PL9D with and without these corrections for physically realizable environments led to insignificant differences. This was true for the PARKA environment which was quite similar to that of LORAD and also resulted in marked convergence zone propagation. It is with the above in mind that Generic FACT was used. Results are presented for only the incoherent phase option. This was not a limitation of the Generic FACT model but was rather an arbitrary choice.

(U) The following plots are given for each of the fourteen LORAD cases: (1) Generic FACT output using the incoherent phase addition option and (2) the Generic FACT result subtracted from the LORAD experimental data. These plots are presented in Figures IIE16-IIE43.

(U) Means and standard deviations of the differences between Generic FACT and LORAD data are given for each case in Table IIE2. A positive mean value indicates less loss for Generic FACT than for LORAD data and the model prediction is therefore optimistic with respect to the experimental result. For this situation detection ranges as predicted by the model are greater than those indicated by the experimental data. For a negative mean value the converse of the above holds.

(C) We now turn to examining the differences between the FACT and LORAD results by the "Difference Method." The reader is encouraged to refer to Table IIE2 and the appropriate figures while reading the following text. We are reminded that Cases IA-IG apply to a receiver at 30.5 meters (100 feet) and Cases IIA-IIG apply to a receiver at 365 meters (1000 feet). In Case IA, the Generic FACT prediction is in substantial agreement with the LORAD data to a range of approximately 38 kilometers in the first bottom bounce region. Past this range Generic FACT shows less loss than the LORAD data although the latter is spread over 15 dB. This effect holds over the final 20 kilometers of the first bottom bounce region. The FACT convergence zone is approximately twice as broad as that observed in LORAD, the FACT CZ peak is at 73 dB compared to LORAD's at 71 dB. The data at the start of the second CZ shows much greater loss for LORAD than is shown by the FCAT prediction. It is the behavior past 38 kilometers of FACT compared to LORAD that primarily accounts for the mean and standard deviation for this case. For Case IIB, the second bottom bounce regions and second CZs of Generic FACT and LORAD are compared. The Generic FACT propagation loss is less than LORADs for the entire second bottom bounce region. Once again the LORAD data is spread over about 15 dB in this region. It should be noted that FACT's highest loss internal bottom loss type (i.e., Type 5) was used in these model runs. Thus, we have the closest agreement possible between Generic FACT and LORAD results in the second and, in fact, the first bottom bounce region. The second CZ as predicted by Generic

FACT starts before and ends after that of the LORAD data. A slight jump in the FACT CZ at about 126 km may indicate that the CZ is anomalously elongated past that range. If Generic FACT coherent results were available the structure of this elongated zone would be evident. Unfortunately this information is not available. In Cases IC through IG, we compare only the convergence zones as observed from LORAD data and predicted by Generic FACT. The LORAD CZ's retain approximately the same width from the third through the fifth zones; the sixth and seventh CZs are somewhat broader. In contrast, the Generic FACT CZs continue to broaden from the first to the seventh (for which the full zone is not presented). The sixth convergence zone of Generic FACT is approximately 55 km in length. For Cases IC-IG, the values of and in Table IIE-2 are somewhat misleading in that they apply to the range interval over which the LORAD data exists (only its comparatively narrow CZ) and should not be interpreted as implying overall agreement of the LORAD and FACT CZs but rather are measures of the agreement of LORAD and FACT over the limited intervals of LORAD's convergence zones. It is also evident from the figures that at the start of the convergence zone, Generic FACT shows a rather abrupt rise which does not change much from CZ to CZ. LORAD's convergence zone starts are equally abrupt to FACT's for the first and second zones. Thereafter, the zone start becomes increasingly gentle with increasing CZ number. Even in the third CZ, a substantial difference is seen in the slope of the CZ start between FACT and LORAD results.

(C) Let us now examine Cases IIA-IIG for which the receiver was at 305 meters (1000 feet). Results for Case IIA are fairly similar to those for Case IA in the first bottom bounce region. Close agreement between Generic FACT predictions and LORAD results is found to a range of about 40 kilometers. From that point to the start of the first convergence zone at about 55 kilometers, the Generic FACT prediction shows less loss than the LORAD data despite the use of a FNOC Type 5 bottom for model runs (the highest loss bottom). Both LORAD data and FACT show a double lobe first convergence zone. Both LORAD and FACT CZs are of approximately the same width but the FACT CZ occurs about 1 kilometer before LORAD's. Case IIB also parallels Case IIA in that the Generic FACT prediction in the second bottom bounce region shows less loss than the LORAD data, despite the use of a Type 5 bottom. The second CZ for FACT has a steeper rise, begins 1 kilometer sooner, and has the same width as LORAD's second CZ. For Cases IIC-IIG, convergence zones three through seven are compared. The FACT CZs retain their steep rise but the LORAD CZs rise with smaller slope as CZ number increases. Even in the third CZ (Case IIC) this difference of slopes is significant.

(C) The extent of the Generic FACT and LORAD CZs are quite similar for Case IIC. This is impossible to determine for the fourth CZ of Case IID since the LORAD data terminates in mid-zone. In Case IIE, the peak of the LORAD fifth CZ is 90 dB compared to 96 dB for Generic FACT. The shapes and levels of the LORAD and FACT convergence zones are so different in this case that it is possible to say only that zone widths are somewhat comparable. In Case IIF, the CZ start is somewhat ill-defined for the LORAD data, yet the LORAD and FACT sixth CZs do share similar levels and shapes. In Case IIG, the convergence zones for LORAD and FACT are again in substantial agreement. This is apparently contradicted in Table IIE-2. What happened was that before the onset of the LORAD and FACT seventh CZs at 415 kilometers, great differences in the seventh bottom bounce region from 407 to 415 km between LORAD and FACT occurred and were responsible for the large values of μ and σ. We note that Generic FACT predicted double lobed CZs for all CZs. LORADs first and second CZs were double lobed; the rest did not appear to be although this feature may be masked by fluctuations.

(C) Detection ranges for LORAD data and Generic FACT predictions as a function of figure of merit (FOM) are given in Tables IIE3-IIE16 for Cases IA-IIG, respectively. The Generic FACT runs were made using incoherent phase addition, which results in a smooth curve free from fluctuations in the bottom bounce regions. The LORAD data shows fluctuations over a range of 15 dB in the same region. The latter's detection coverage must therefore be described as "zonal detection coverage" given in a percentage which approximates the percentage of points characterized by less propagation loss than the FOM against which detection performance is being measured (over a stated range interval). For Case IA, LORAD shows much longer detection coverage than that predicted by Generic FACT for FOMs between 80 and 85 dB. At FOM = 90 dB, the maximum range of detection is 40 km for both data sets in the first bottom bounce region. As FOM increases past 90 dB the Generic FACT detection ranges are increasingly longer than LORAD's. The LORAD CZ starts 1.5 km later than FACT for all FOMs. The FACT CZ end is 2 km longer than LORAD's at FOM = 75 dB and increases to 5 km longer at FOM = 95 dB. In Case IB, neither FACT nor LORAD shows no second bottom bounce region coverage for FOM $\leq$ 95 dB. Beyond this FACT shows greater second bottom bounce region coverage until at FOM = 110 dB, both LORAD and FACT show coverage until the second convergence zone. The Generic FACT second CZ starts 3 km before LORAD's for all FOMs. For FOM = 80 and 85 dB LORAD's second CZ is longer than FACT's by 3.5 and 1.5 km, respectively. For FOM $\geq$ 90 dB the situation is reversed and at FOM = 95 dB the FACT CZ extends 4 km past LORAD's. In Case IC, the third convergence zone start of FACT precedes that of LORAD by 4.5 km at FOM = 85 dB and falls to a lead of 2.5 km at FOM = 105 dB. The corresponding CZ ends are 5 km and 10.5 km longer for FACT at FOM = 85 dB and 105 dB, respectively. This pattern is maintained and intensified in Cases ID-IG. As we move to successive zones, the comparison of zone starts between Generic FACT and LORAD remains roughly the same. The convergence zone widths, however, become increasingly longer for Generic FACT whereas they remain approximately constant for LORAD data. With the relation between zone starts remaining unchanged, this means that the zone ends must (and do) increasingly disagree with each succeeding convergence zone. Generic FACT for the sixth CZ is 50% wider than is LORAD's CZ at FOM = 110 dB.

(C) In Case IIA, in the first bottom bounce region we find broader detection coverage for LORAD than is predicted by Generic FACT by large amounts for FOM = 80 dB and 85 dB. The LORAD coverage, however, is very spotty as can be seen by the Zonal Detection Coverage of 10% over all (for FOM = 80 dB) or most (for FOM = 85 dB) of the detection interval. For FOM = 90 dB and 95 dB, LORAD and Generic FACT predict nearly equal coverage. For FOM $\geq$ 100 dB, Generic FACT predicts more extensive detection coverage than is indicated by LORAD. The FACT detection coverage is almost double LORAD's at FOM = 105 dB. For the first convergence zone, LORAD shows a zone at FOM = 80 dB whereas FACT predicts no zone at this level. For FOM = 85 dB, the FACT and LORAD CZs have the same width but the FACT CZ occurs 2 km sooner. For FOM = 90 dB, the CZs start at the same range; the LORAD CZ extends 1 km past FACT's CZ. At FOM = 95 dB, the CZ ends are at the same range but FACT's CZ starts 2 km later than LORAD's. For FOM = 100 dB, LORAD shows a CZ whereas Generic FACT predicts continuous detection coverage to beyond the first CZ. In Case IIB, we see that neither Generic FACT nor LORAD predict detection in the second bottom bounce region for FOM $\leq$ 100 dB. For FOM $\geq$ 105 dB, LORAD and FACT show roughly equivalent detection coverage in the second bottom bounce region. The second convergence zone widths are roughly the same at all FOMs for both LORAD and Generic FACT. The zone offsets decrease from 3.5 km at FOM = 90 dB to -0.5 km at FOM = 105 dB, the negative sign indicating that the LORAD CZ precedes that of FACT. For Case

IIC, the third convergence zone starts for LORAD vary from 180.5 km at FOM = 95 dB to 173.5 km at FOM = 110 dB; Generic FACT CZ start ranges vary from 177.5 to 176.5 km over the same FOM interval. The Generic FACT CZ end always precedes that of LORAD by approximately 6 km. For Case IID, the LORAD data does not extend far enough to define the end of the fourth convergence zone. The CZ start of LORAD precedes that of FACT by 1 to 2 km over the span of FOMs. This translates into a maximum start range error of less than 2% of the total range. The Generic FACT zone start of the fifth CZ (Case IIE) is also in error by less than 2% of the total range, the LORAD start range being smaller. The LORAD CZ end is greater than FACT's. The result is a Generic FACT CZ width which is two to three times narrower than LORAD's. Cases IIF and IIG show the same general behavior as was observed in Case IIE.

(C) The comparison between LORAD and Generic FACT may be summarized as follows: (1) Good agreement was achieved in the first bottom bounce region to about 40 km beyond which FACT predicted less loss than was found in LORAD until the first CZ was reached. The discrepancy increased with increasing range. This result was independent of receiver depth. (2) The Generic FACT prediction showed less loss than did LORAD data through the second bottom bounce region despite the use of FACT's lossiest bottom (i.e., Type 5). This result was independent of receiver depth. (3) For the 100 foot (30.5 m) receiver: (a) The FACT CZ start always occurred at shorter range than LORADs; (b) The slope of the CZ start was the same for all of FACT's seven CZs whereas the LORAD CZ slopes agreed with FACT for CZ 1 and CZ 2 but became increasingly gentle with additional CZs; (c) The CZ end for FACT always extended beyond that for LORAD; (d) The LORAD CZs increase in width much more slowly than do FACT CZs with increasing zone number. (4) For the 1000 foot (30.5 m) receiver: (a) The first two CZs are double-lobed for LORAD; all CZs are double-lobed for Generic FACT predictions; (b) The first two CZs are of approximately the same width for LORAD and FACT. Differences in zone start and end are FOM dependent, (c) For the third CZ and beyond, start ranges generally differ by less than 2% of the entire range; (d) The fourth through seventh convergence zones are generally much narrower (factor of 2 is typical) for Generic FACT than for LORAD.

References (U)

1. Martin, R. L. et al. (1982). The Acoustic Model Evaluation Committee (AMEC) Reports. Volume IA. Summary of Range Independent Environmental Acoustic Propagation Loss Data Sets (U). Naval Ocean Research and Development Activity Report No. 34. CONFIDENTIAL

(C) Table IIE-1. Bottom Loss (dB) versus Grazing Angle (degrees). FNOC Type 5. Frequency = 530 Hz.

Grazing Angle	Bottom Loss
0.0	0.0
2.5	8.0
5.0	8.7
7.5	10.0
15.0	14.1
17.5	15.0
20.0	15.8
22.0	16.0
90.0	16.0

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(C) Table IIE-2. Means (μ) and Standard Deviation (σ) in dB of Differences Obtained by Subtracting Generic FACT[1] Incoherent Results from LORAD Experimental Data.

Case	Run Number	Frequency (Hz)	Source Depth (m)	Receiver Depth (m)	μ	σ
IA	3S	530	15.2	30.5	3.0	5.5
IB	6S	530	15.2	30.5	9.1	7.0
IC	8S	530	15.2	30.5	1.8	5.4
ID	10S	530	15.2	30.5	0.1	3.5
IE	12S	530	15.2	30.5	0.9	3.9
IF	14S	530	15.2	30.5	1.0	4.2
IG	16S	530	15.2	30.5	2.3	8.7
IIA	3D	530	15.2	304.8	1.8	4.3
IIB	6D	530	15.2	304.8	6.5	5.8
IIC	8D	530	15.2	304.8	-0.3	2.6
IID	10D	530	15.2	304.8	-0.1	3.1
IIE	12D	530	15.2	304.8	-0.8	4.2
IIF	14D	530	15.2	304.8	-1.9	5.6
IIG	16D	530	15.2	304.8	-7.1	11.8

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.

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(C) Table IIE-3. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 3S Data (2-73 km) and Generic FACT[1] Incoherent Model Results. (Source Depth = 15.2 m, Receiver Depth = 30.5 m, Frequency = 530 Hz). Bottom Loss: FNOC Type 5.

Data Set	FOM	R_c[2]	First Bottom Bounce Region	1st CZ Start	1st CZ End
LORAD 3S	75	---		61.5	63.0
Generic FACT	75	2.0		59.0	61.0
LORAD 3S	80	---	ZDC[3] 10%, 3-8 km	61.0	63.5
Generic FACT	80	2.5		59.0	63.0
LORAD 3S	85	---	ZDC 50%, 3-8 km	60.5	64.0
Generic FACT	85	4.5		59.0	65.5
LORAD 3S	90	---	ZDC 90%, 3-10 km; ZDC 40%, 10-20 km, ZDC 50%, 20-30 km; ZDC 20%, 35-40 km	60.0	64.5
Generic FACT	90	40.0		58.5	68.0
LORAD 3S	95	10.0	ZDC 80%, 10-30 km; ZDC 50%, 30-41 km; ZDC 20%, 41-51 km	60.0	65.0
Generic FACT	95	58.0		58.0	70.0
LORAD 3S	100	32.0	ZDC 85%, 32-42 km; ZDC 50%, 42-50 km; ZDC 30%, 50-57 km	59.5	65.0
Generic FACT	100	86.0			
LORAD 3S C	105	46.0	ZDC 90%, 46-51 km; ZDC 50%, 51-58 km	58.0	65.5
Generic FACT	105	139.0			
LORAD 3S	110	52.0	ZDC 90%, 52-58 km		66.0
Generic FACT	110	155.0			

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.
2. R_c = Range to which coverage is continuous.
3. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.

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(C) Table IIE-4. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 6S (73-132.5 km) and Generic FACT[2] Incoherent Model Results. (Source Depth = 15.2 m, Receiver Depth = 30.5 m, Frequency = 530 Hz). Bottom Loss: FNOC Type 5.

Data Set	FOM	Second Bottom Bounce Region	2nd CZ Start	2nd CZ End
LORAD 6S	80		123.0	124.0
Generic FACT	80		120.5	120.5
LORAD 6S	85		122.5	125.5
Generic FACT	85		119.0	124.0
LORAD 6S	90		122.0	126.0
Generic FACT	90		119.0	128.0
LORAD 6S	95		121.5	130.0
Generic FACT	95		118.5	134.0
LORAD 6S	100		119.0	131.5
Generic FACT	100	Continuous coverage to 86 km	118.5	137.0
LORAD 6S	105	ZDC[2] 25%, 75-110 km	------	-----
Generic FACT	105	Continuous coverage to 139 km	118.0	139.0
LORAD 6S	110	ZDC 60%, 75-118 km		
Generic FACT	110	Continuous coverage to 155 km		

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.
2. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.

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(C) Table IIE-5. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 8S Data and Generic FACT[1] Incoherent Model Results (Source Depth = 15.2 m, Receiver Depth = 30.5 m, Frequency = 530 Hz). Bottom Loss: FNOC Type 5.

Data Set	FOM	3rd CZ Start	3rd CZ End
LORAD 8S	85	184.5	185.5
Generic FACT	85	180.0	180.5
LORAD 8S	90	184.0	189.0
Generic FACT	90	179.0	184.5
LORAD 8S	95	182.5	191.0
Generic FACT	95	178.5	193.0
LORAD 8S	100	182.0	192.0
Generic FACT	100	178.5	200.0
LORAD 8S	105	181.0	193.5
Generic FACT	105	178.5	204.0

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.

(C) Table IIE-6. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 10S Data and Generic FACT[1] Incoherent Model Results (Source Depth = 15.2 m, Receiver Depth = 30.5 m, Frequency = 530 Hz). Bottom Loss: FNOC Type 5.

Data Set	FOM	4th CZ Start	4th CZ End
LORAD 10S	90	240.5	251.5
Generic FACT	90	239.5	241.5
LORAD 10S	95	238.5	252.5
Generic FACT	95	239.0	250.0
LORAD 10S	100	238.0	253.5
Generic FACT	100	239.0	258.0
LORAD 10S	105	237.5	254.0
Generic FACT	105	238.5	268.5

1. The Generic FACT Model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.

(C) Table IIE-7. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 12S Data and Generic FACT[1] Incoherent Model Results. (Source Depth = 15.2 m, Receiver Depth = 30.5 m, Frequency = 530 Hz). Bottom Loss = FNOC Type 5.

Data Set	FOM	5th CZ Start	5th CZ End
LORAD 12S	90	307.0	310.5
Generic FACT	90	-----	-----
LORAD 12S	95	305.5	314.5
Generic FACT	95	299.5	302.5
LORAD 12S	100	304.5	316.0
Generic FACT	100	299.0	314.5
LORAD 12S	105	302.0	317.0
Generic FACT	105	298.5	327.0

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.

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(C) Table IIE-8. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 14S Data and Generic FACT[1] Incoherent Model Results (Source Depth = 15.2 m, Receiver Depth = 30.5 m, Frequency = 530 Hz). Bottom Loss = FNOC Type 5.

Data Set	FOM	6th CZ Start	6th CZ End
LORAD 14S	95	364.0	373.0
Generic FACT	95	359.5	361.0
LORAD 14S	100	363.5	377.5
Generic FACT	100	359.0	365.5
LORAD 14S	105	361.0	382.5
Generic FACT	105	358.5	378.0
LORAD 14S	110	360.5	385.0
Generic FACT	110	358.5	394.0

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.

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(C) Table IIE-9. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 16S Data and Generic FACT[1] Incoherent Model Results (Source Depth = 15.2 m, Receiver Depth = 30.5 m, Frequency = 530 Hz). Bottom Loss = FNOC Type 5.

Data Set	FOM	7th CZ Start
LORAD 16D	100	423.0
Generic FACT	100	420.5
LORAD 16S	105	420.0
Generic FACT	105	419.0
LORAD 16S	110	418.5
Generic FACT	110	418.5

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.

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(C) Table IIE-10. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 3D Data (2.5-71.0 km) and Generic FACT[1] Incoherent Model Results. (Source Depth = 15.2 m, Receiver Depth = 305 m, Frequency = 530 Hz). Bottom Loss = FNOC Type 5.

Data Set	FOM	R_c[2]	First Bottom Bounce Region	1st CZ[5] Start	1st CZ[5] End
LORAD 3D	80	-----	ZDC[3] 90%, 2.5-7.5 km	63.5[4]	64.5
Generic FACT	80	3.0		----	----
LORAD 3D	85	-----	ZDC 60%, 2.5-8.0 km, ZDC 10%, 8.0-31.5 km	59.0	65.0
Generic FACT	85	4.0		57.0	63.5
LORAD 3D	90	-----	ZDC 90%, 2.5-8.0 km, ZDC 60%, 8-15 km, ZDC 40%, 15-32 km, ZDC 90%, 32-40 km	57.5	65.5
Generic FACT	90	37.0		57.5	64.5
LORAD 3D	95	-----	ZDC 90%, 25-30.0 km, ZDC 80%, 30-40 km, ZDC 20%, 40-50 km	55.5	66.5
Generic FACT	95	52.0		57.5	66.5
LORAD 3D	100	32.0	ZDC 90%, 32-41 km, ZDC 50%, 41-50 km, ZDC 20%, 50-58.5 km	55.0	67.0
Generic FACT	100	72.5		-----	-----
LORAD 3D	105	41.5	ZDC 95%, 41.5-50 km, ZDC 50%, 50-58 km	-----	-----
Generic FACT	105	108.5		-----	-----
LORAD 3D	110	52.0	ZDC 80%, 52-57 km	-----	-----
Generic FACT	110	142.5		-----	-----

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.
2. R_c = Range to which coverage is continuous.
3. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.
4. Start range for second lobe of convergence zone.
5. Convergence zone is double lobed to a maximum loss of 99 dB for LORAD data; to 96 dB for Generic FACT.

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(C) Table IIE-11. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 6D Data (71-132.5 km) and Generic FACT[1] Incoherent Model Results. (Source Depth = 15.2 m, Receiver Depth = 305 m, Frequency = 530 Hz). Bottom Loss = FNOC Type 5.

Data Set	FOM	Second Bottom Bounce Region	2nd CZ[3] Start	2nd CZ[3] End
LORAD 6D	85		121.0	122.0[4]
Generic FACT	85		-----	-----
LORAD 6D	90		120.5	127.5
Generic FACT	90		117.0	123.0
LORAD 6D	95		118.0	128.0
Generic FACT	95		117.0	127.0
LORAD 6D	100		117.0	129.0
Generic FACT	100		116.5	127.5
LORAD 6D	105	ZDC[2] 10%, 71-97.5 km	115.5	131.0
Generic FACT	105	100% Detection Coverage to 108.5 km	116.0	131.0
LORAD 6D	110	ZDC 90%, 71-78 km, ZDC = 50%, 78-113 km	115.0	132.0
Generic FACT	110	100% Detection Coverage	-----	-----
LORAD 6D	115	ZDC 90%, 71-106 km, ZDC 70%, 106-115 km	-----	-----
Generic FACT	115	100% Detection Coverage	-----	-----

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.
2. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.
3. Convergence zone is double lobed to 91 dB for LORAD, 93 dB for Generic FACT.
4. This is the end range of the first lobe of the second convergence zone.

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(C) Table IIE-12. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 8D Data and Generic FACT[1] Incoherent Model Results (Source Depth = 15.2 m, Receiver Depth = 305 m, Frequency = 530 Hz). Bottom Loss = FNOC Type 5.

Data Set	FOM	3rd CZ Start	3rd CZ End
LORAD 8D	90	182.5	186.0
Generic FACT	90	-----	-----
LORAD 8D	95	180.5	190.5
Generic FACT	95	177.5	184.0
LORAD 8D	100	177.0	195.5
Generic FACT	100	177.0	190.0
LORAD 8D	105	175.0	196.0
Generic FACT	105	177.0	190.0
LORAD 8D	110	173.5	199.0
Generic FACT	110	176.5	194.5

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.

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(C) Table IIE-13. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 10D Data and Generic FACT[1] Incoherent Model Results (Source Depth = 15.2 m, Receiver Depth = 305 m, Frequency = 530 Hz). Bottom Loss = FNOC Type 5.

Data Set	FOM	4th CZ Start	4th CZ End[2]
LORAD 10D	95	240.0	-----
Generic FACT	95	242.5[3]	242.5
LORAD 10D	100	238.0	-----
Generic FACT	100	237.0	247.0
LORAD 10D	105	234.0	-----
Generic FACT	105	237.0	252.5
LORAD 10D	110	232.0	-----
Generic FACT	110	236.5	252.5

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.
2. The LORAD data does not extend to the end of the convergence zone.
3. The Generic FACT convergence zone is double lobed to 102 dB.

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(C) Table IIE-14. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 12D Data and Generic FACT[1] Incoherent Model Results (Source Depth = 15.2 m, Receiver Depth = 305 m, Frequency = 530 Hz). Bottom Loss = FNOC Type 5.

Data Set	FOM	5th CZ Start	5th CZ End
LORAD 12D	95	308.0	314.0
Generic FACT	95	-----	-----
LORAD 12D	100	299.0[2]	316.5[2]
Generic FACT	100	297.5	303.0
LORAD 12D	105	293.0	318.0
Generic FACT	105	297.5	312.0
LORAD 12D	110	290.5	319.0
Generic FACT	110	297.0	315.5

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.
2. The Generic FACT convergence zone is double lobed to 104 dB.

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(C) Table IIE-15. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 14D Data and Generic FACT[1] Incoherent Model Results (Source Depth - 15.2 m, Receiver Depth = 305 m, Frequency = 530 Hz). Bottom Loss = FNOC Type 5.

Data Set	FOM	6th CZ Start	6th CZ End
LORAD 14D	100	357.5	376.0
Generic FACT	100	362.5[2]	362.5[2]
LORAD 14D	105	354.5	379.0
Generic FACT	105	357.5	365.5
LORAD 14D	110	352.5	380.0
Generic FACT	110	357.0	375.5

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.
2. The Generic FACT convergence zone is double lobed to 107 dB.

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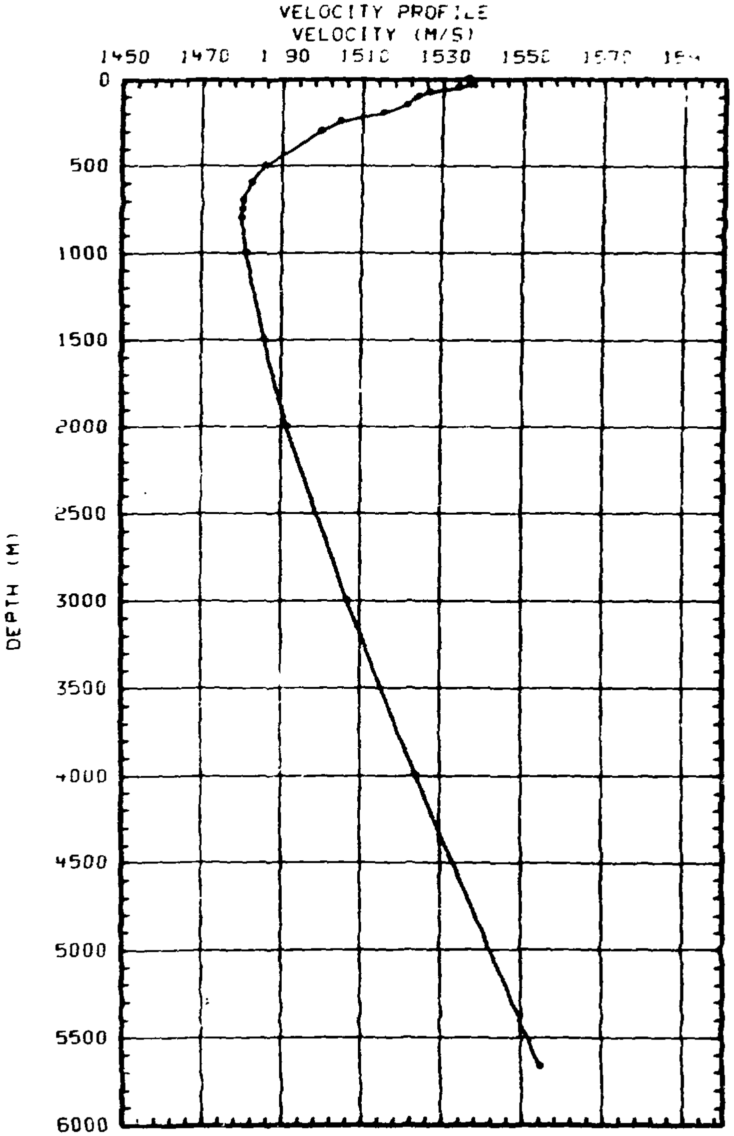
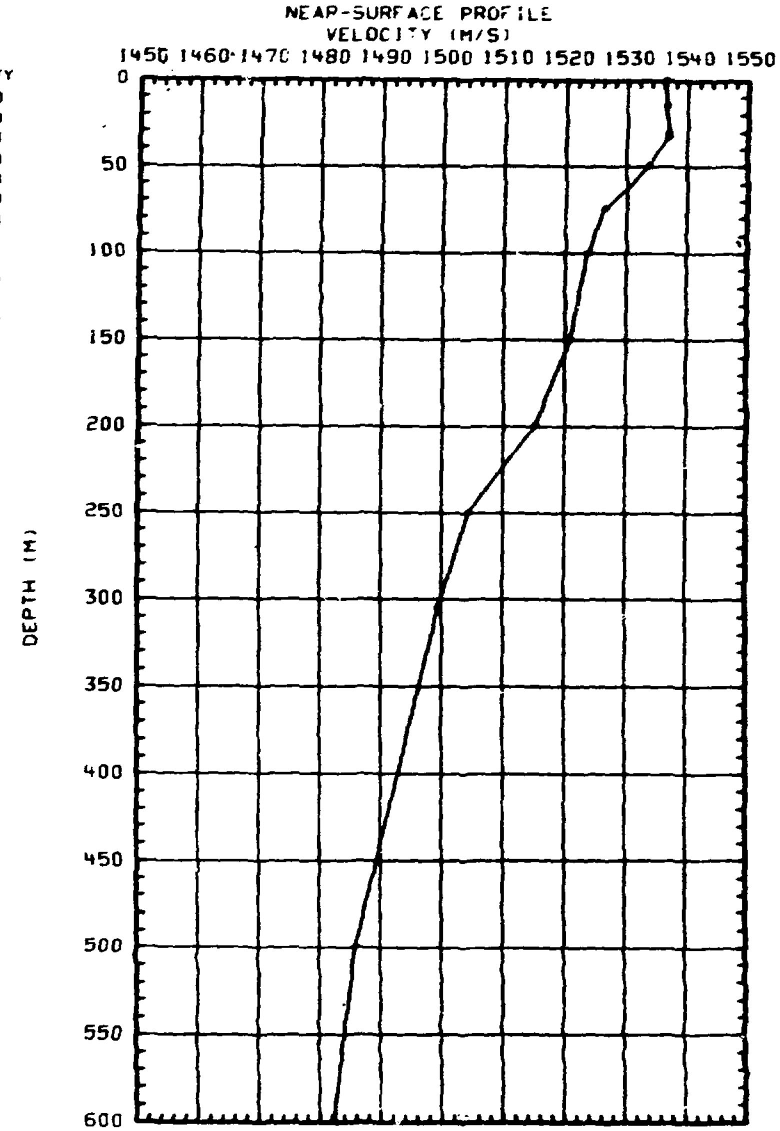
(C) Table IIE-16. Detection Range in km as a Function of Figure of Merit (FOM) in dB for LORAD Run 16D Data and Generic FACT[1] Incoherent Model Results (Source Depth = 15.2 m, Receiver Depth = 305 m, Frequency = 530 Hz). Bottom Loss = FNOC Type 5.

Data Set	FOM	7th CZ Start	7th CZ End
LORAD 16D	100	415.0	438.5
Generic FACT	100	-----	-----
LORAD 16D	105	414.0	439.0
Generic FACT	105	417.5	422.5
LORAD 16D	110	413.5	439.5
Generic FACT	110	417.5	432.5

1. The Generic FACT model was used instead of FACT PL9D because the LORAD ranges and data densities required independent selection of model start range and range increment.
2. The Generic FACT convergence zone is double lobed to 109 dB.



DEPTH	VELOCITY
0.0	1536.20
15.2	1536.50
30.5	1536.80
33.0	1536.80
33.5	1536.70
50.0	1533.60
75.0	1526.30
100.0	1523.60
150.0	1520.80
200.0	1515.10
250.0	1504.30
304.8	1499.42
305.0	1499.40
500.0	1485.90
600.0	1482.30
700.0	1480.10
750.0	1479.90
800.0	1480.00
1000.0	1481.10
1500.0	1485.60
2000.0	1491.30
3000.0	1506.80
4000.0	1523.90
5670.0	1554.70



LORAD RUNS 3D,6D, OWN BOTTOM LOSS. F=0.53KH. ZS=15M. ZR=305M

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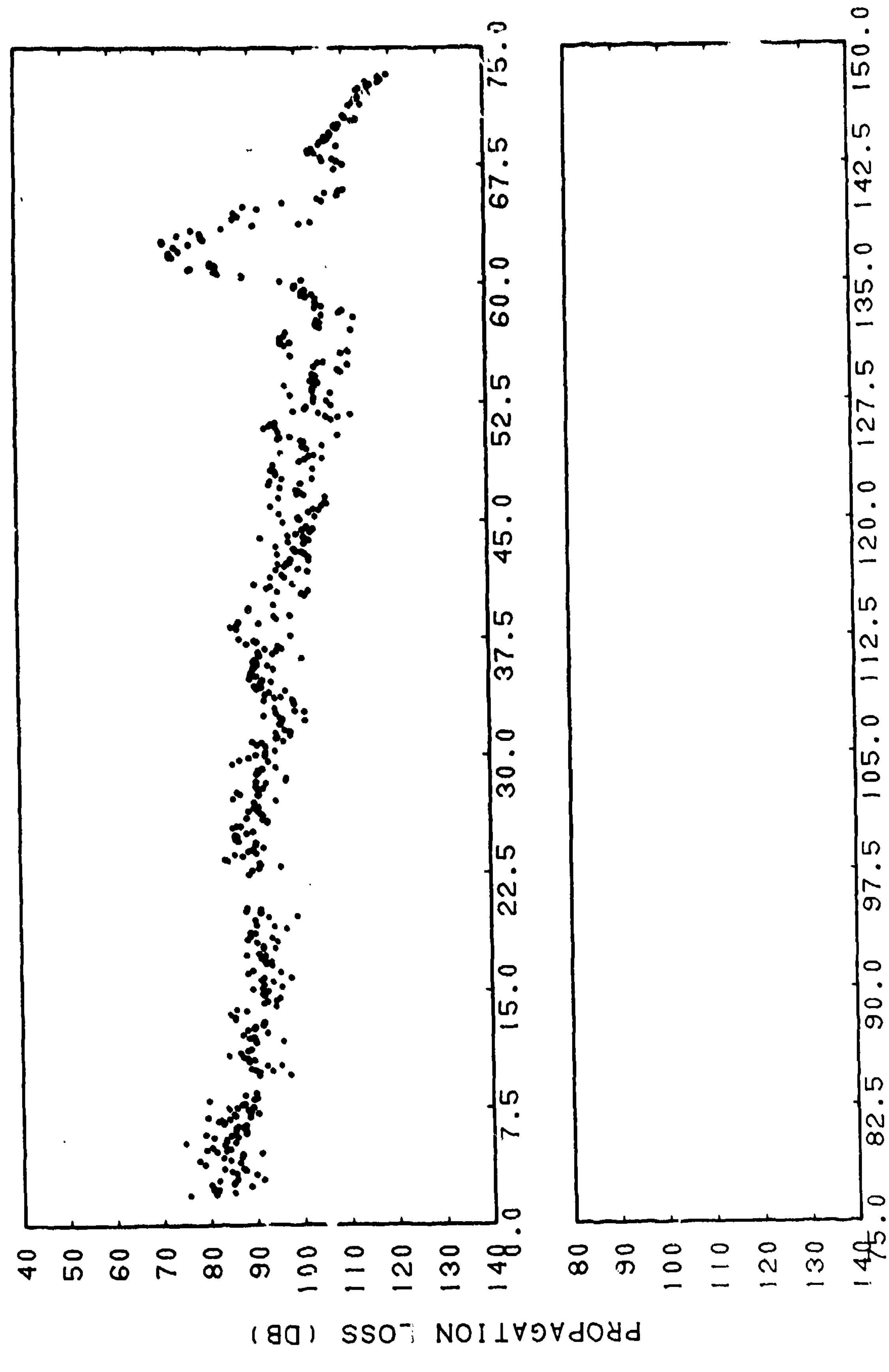
(U) Figure IIE-1. LORAD Sound Speed Versus Depth Profile



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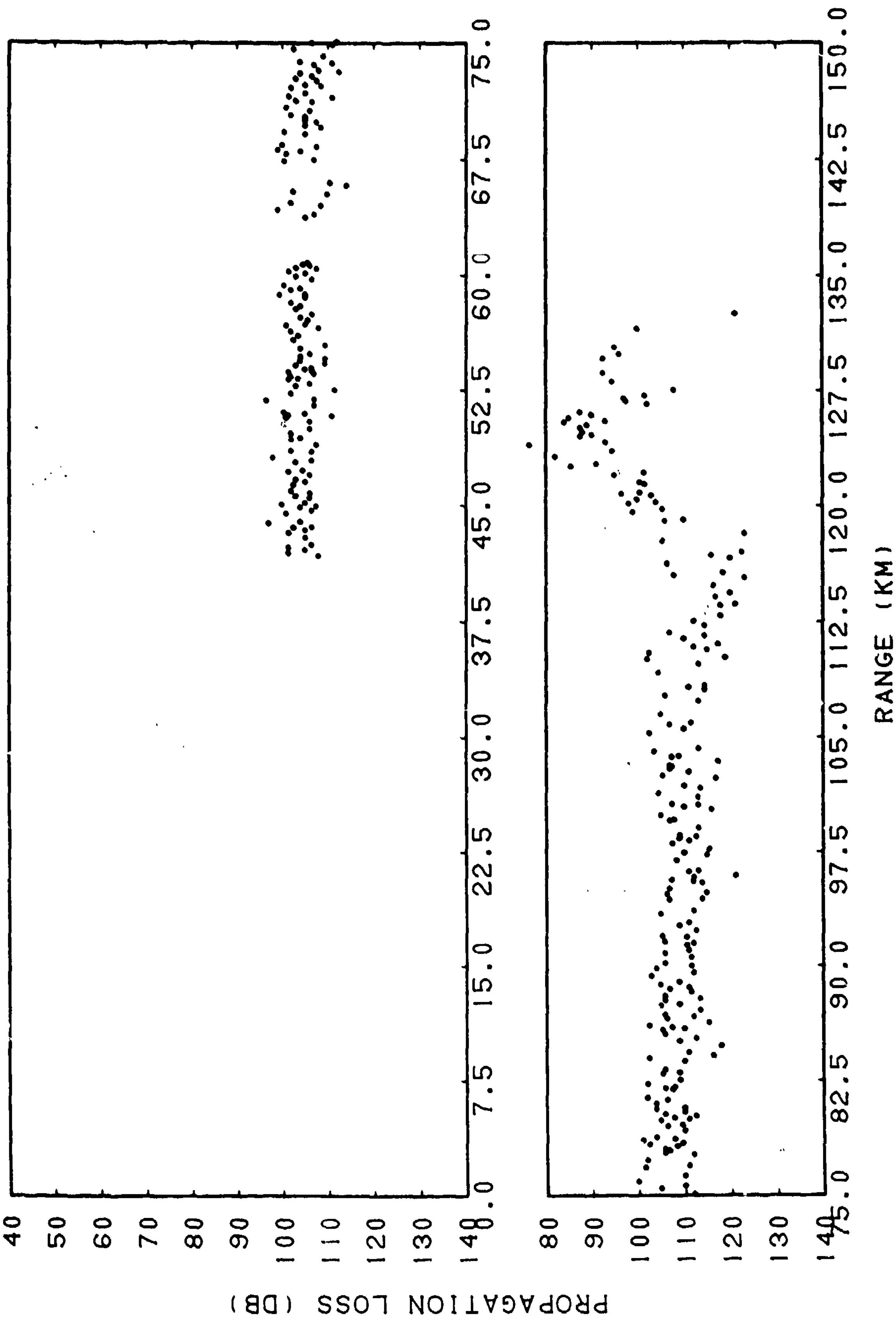
(C) Figure IIE-2. LORAD Run 3S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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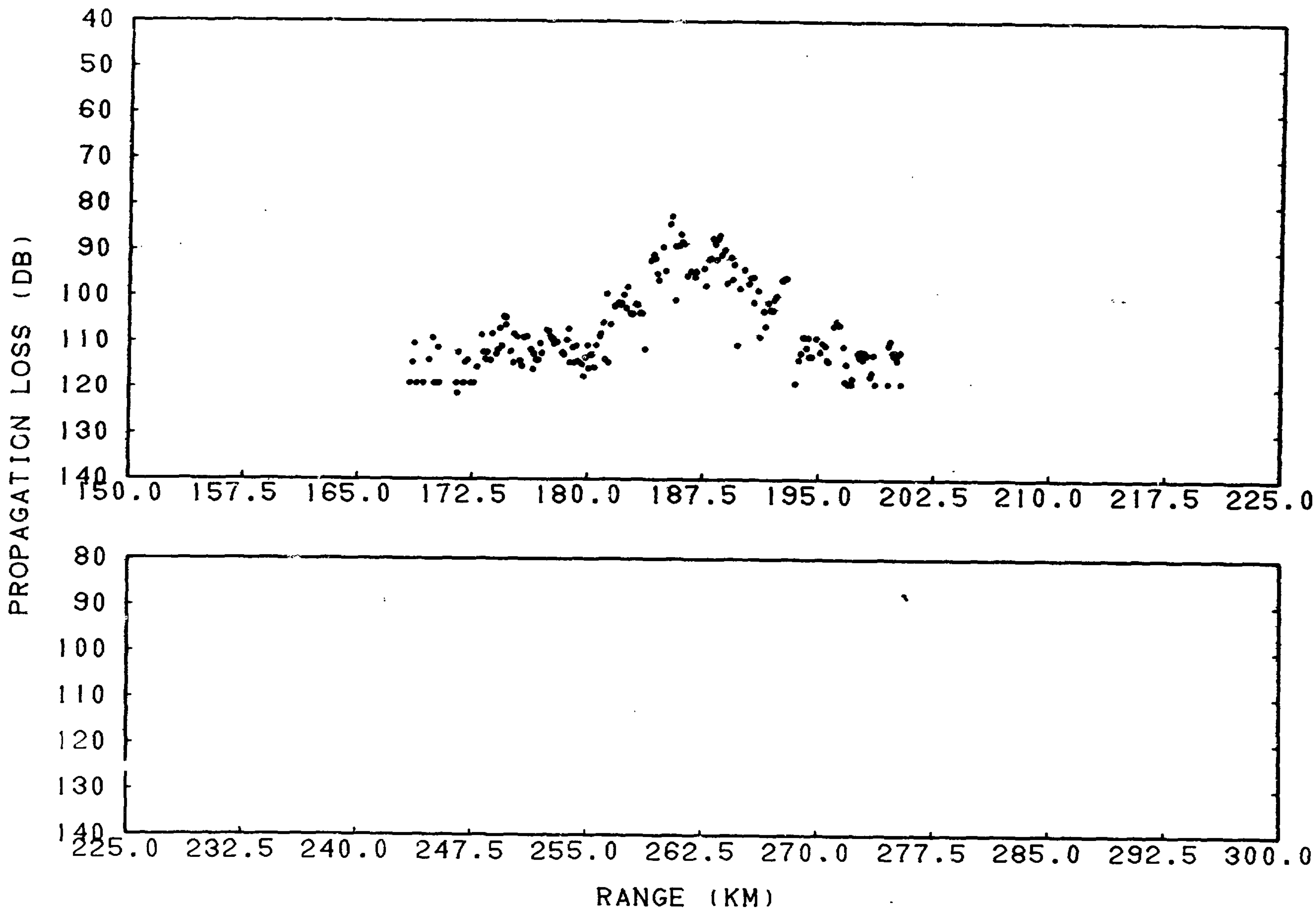
(C) Figure IIIE-3. LORAD Run 6S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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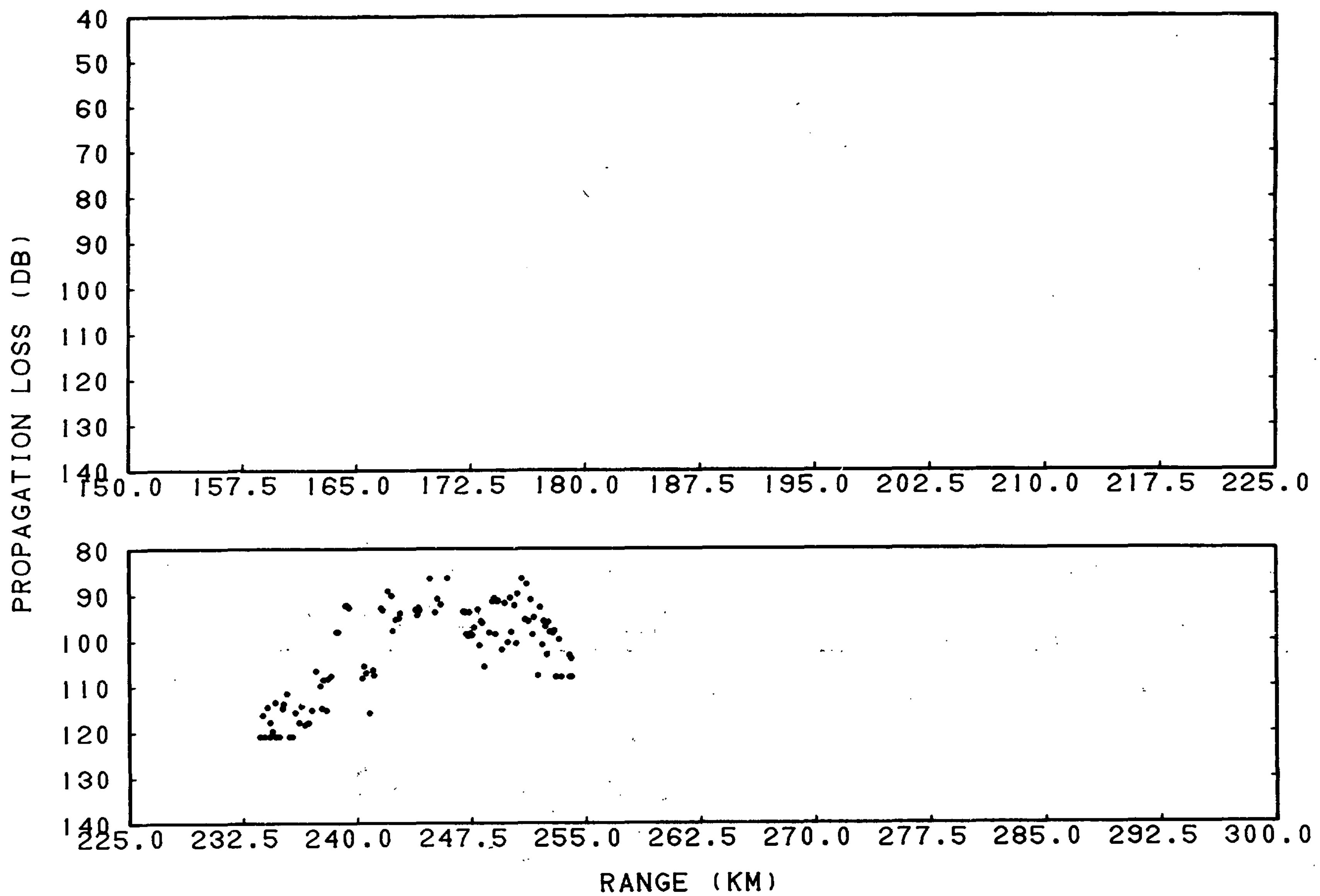
(C) Figure IIE-4. LORAD, Run 8S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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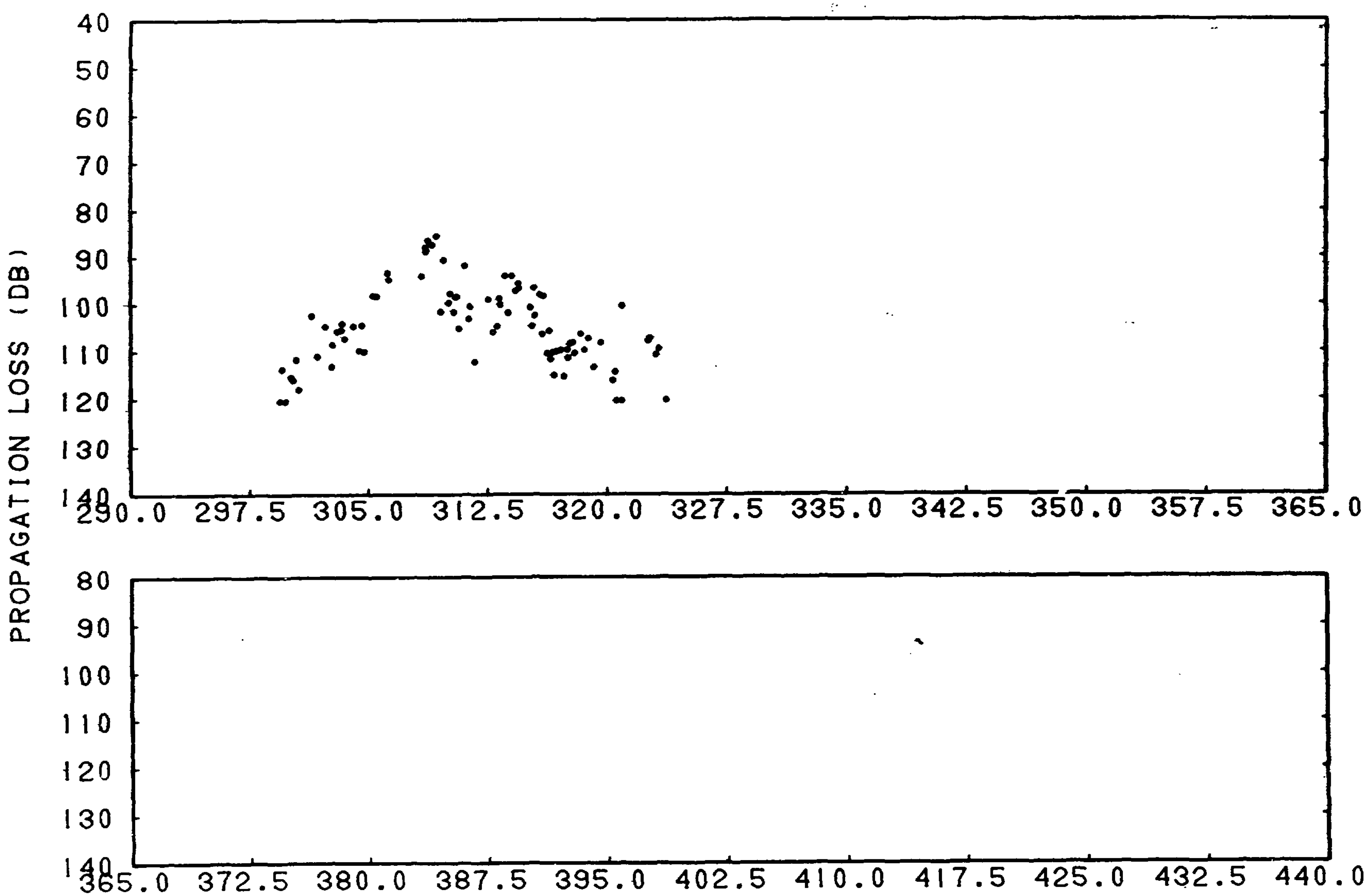
(C) Figure IIE-5. LORAD Run 10S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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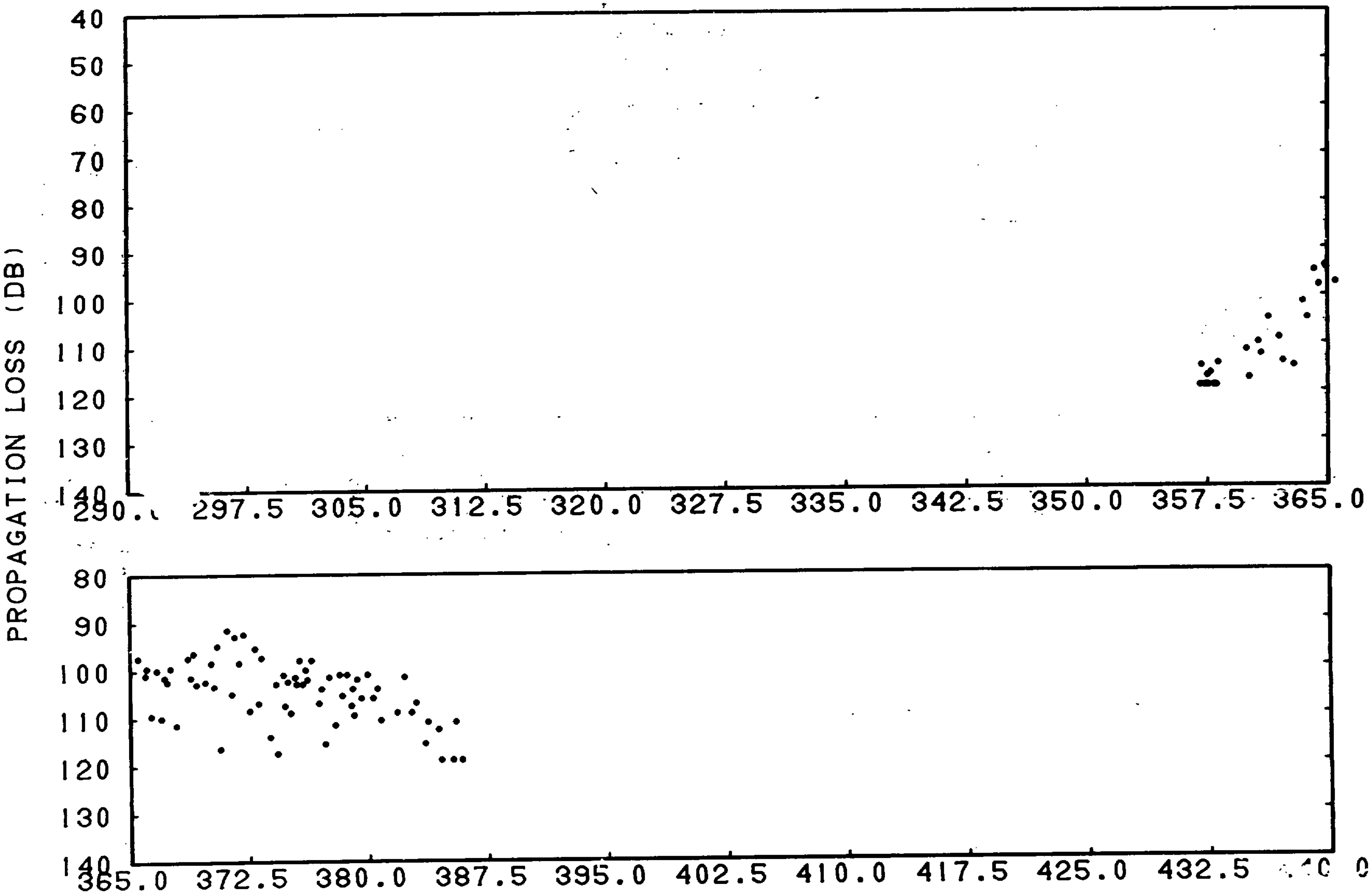
(C) Figure IIE-6. LORAD Run 12S, Frequency = 0.53 Kilohertz, Source Depth = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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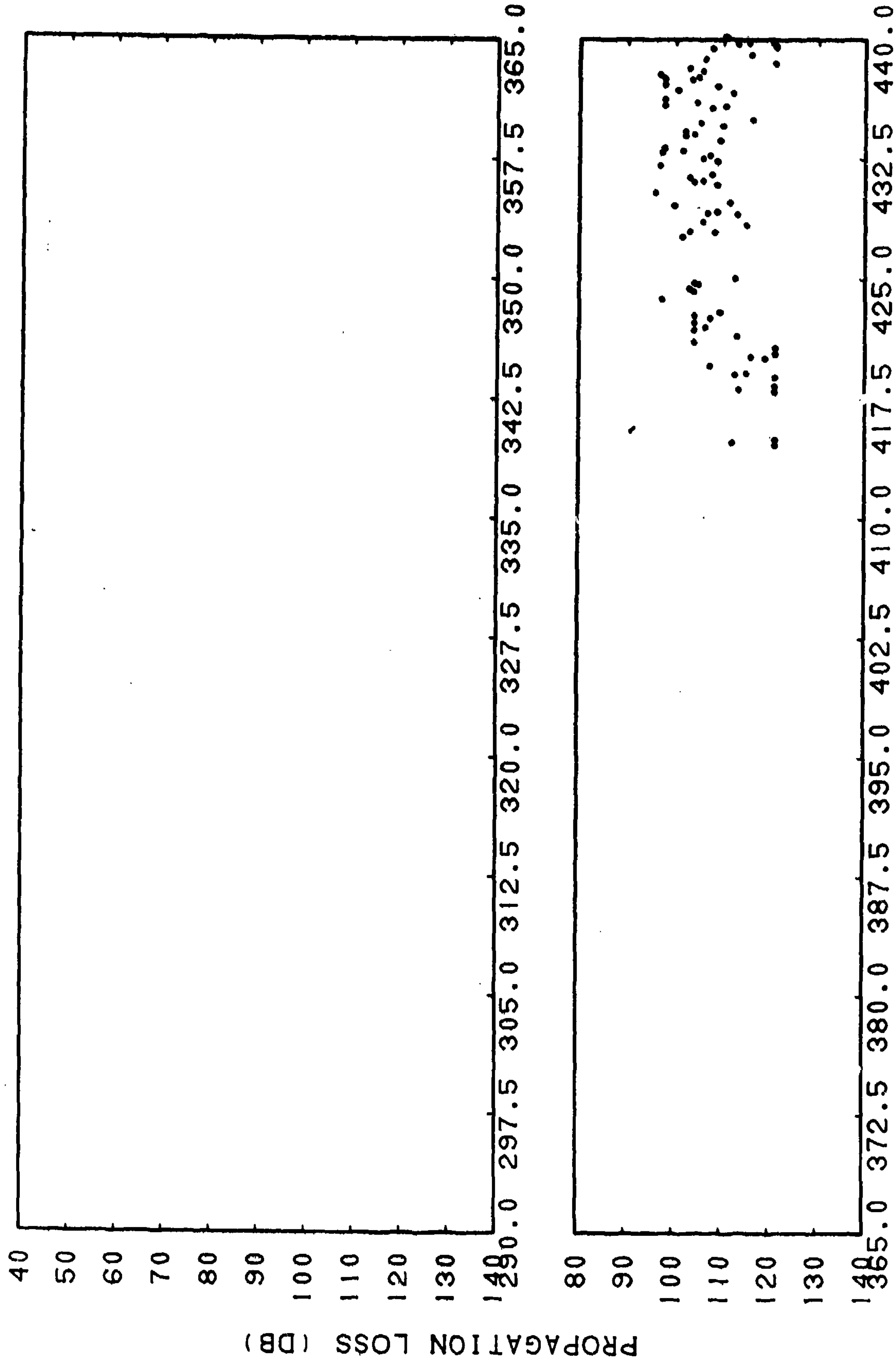
(C) Figure IIE-7. LORAD Run 14S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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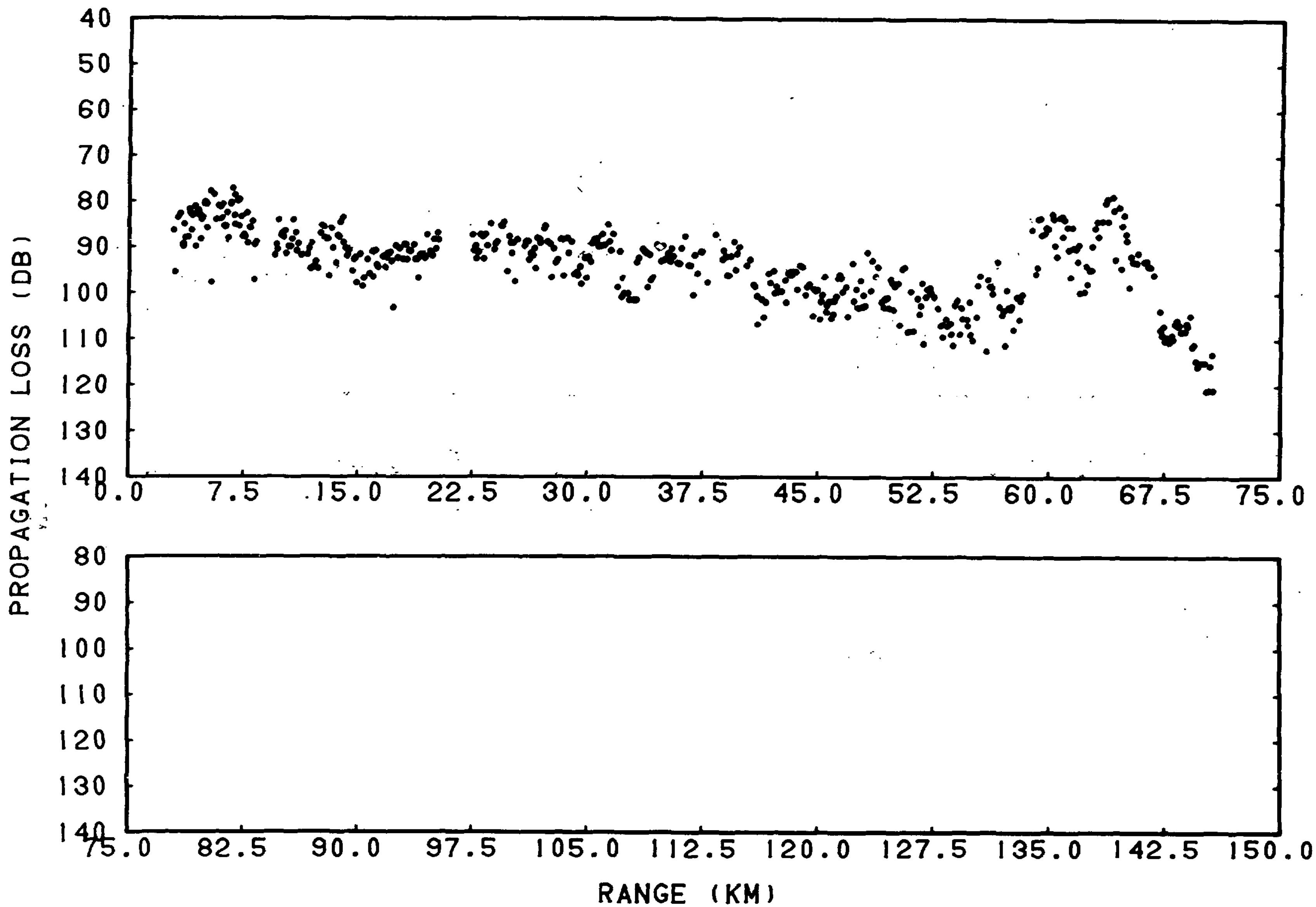
(C) Figure IIIE-8. LORAD Run 16S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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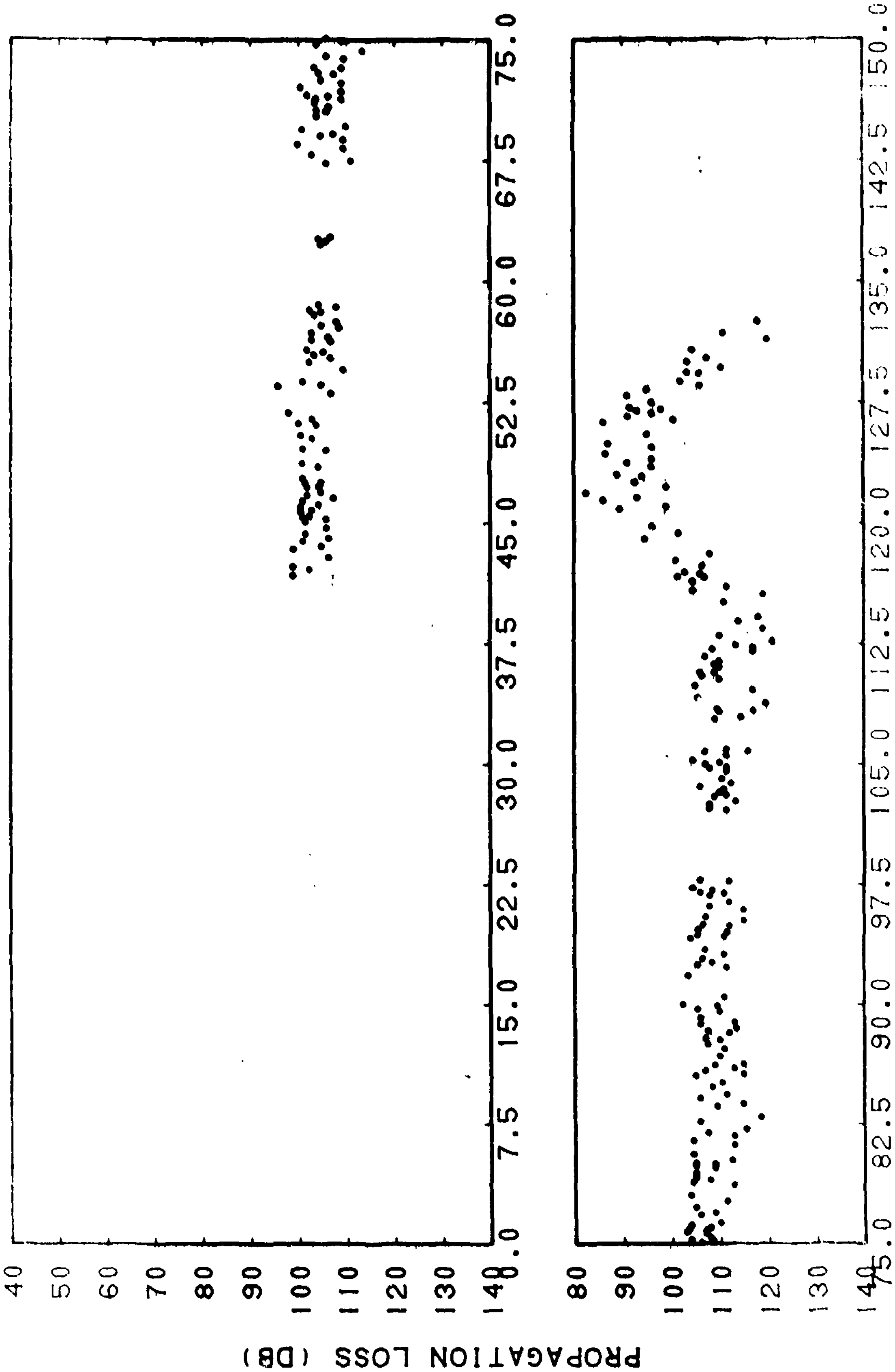
(C) Figure IIE-9. LORAD Run 3D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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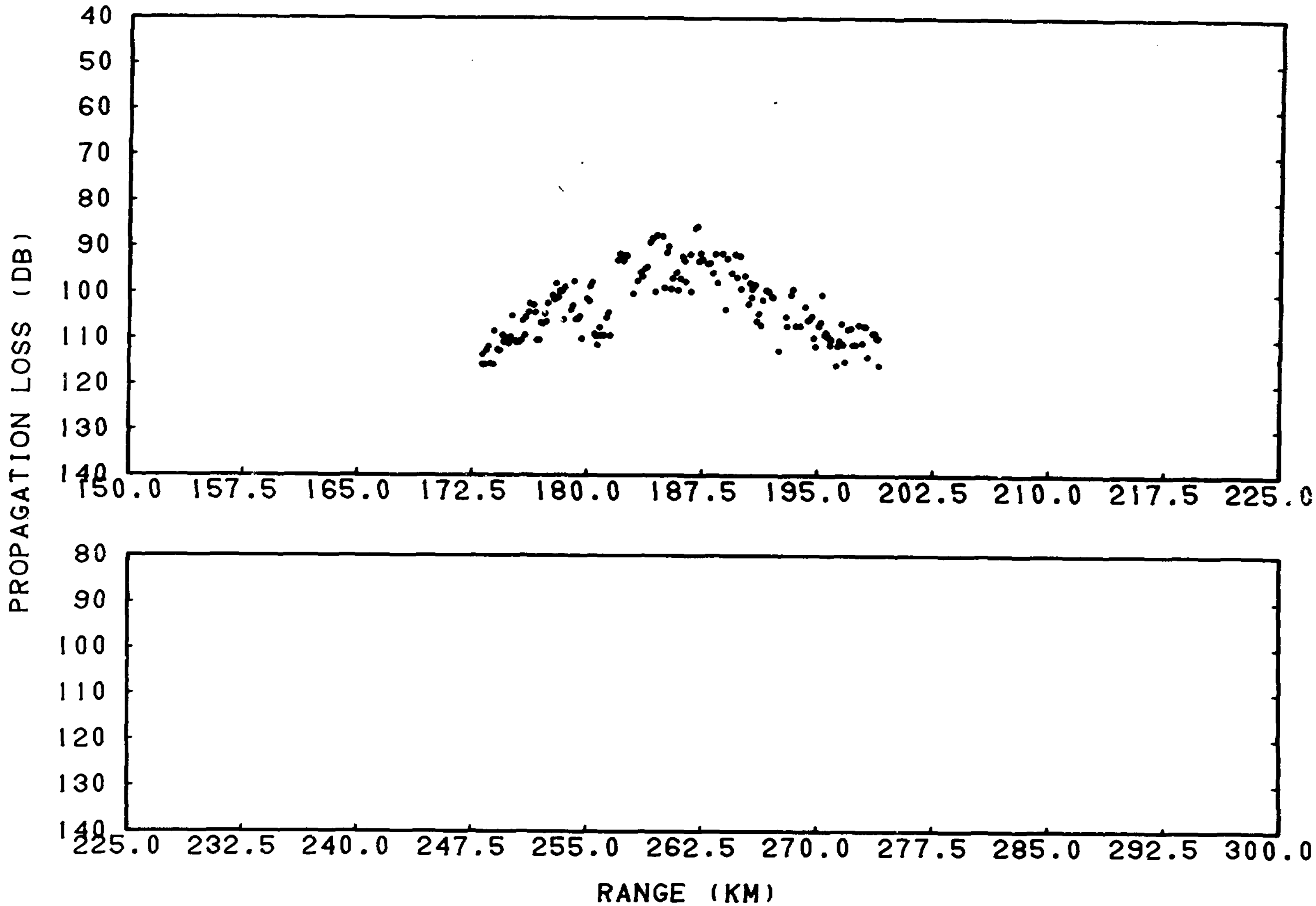
(C) Figure IIE-10. LORAD Run 6D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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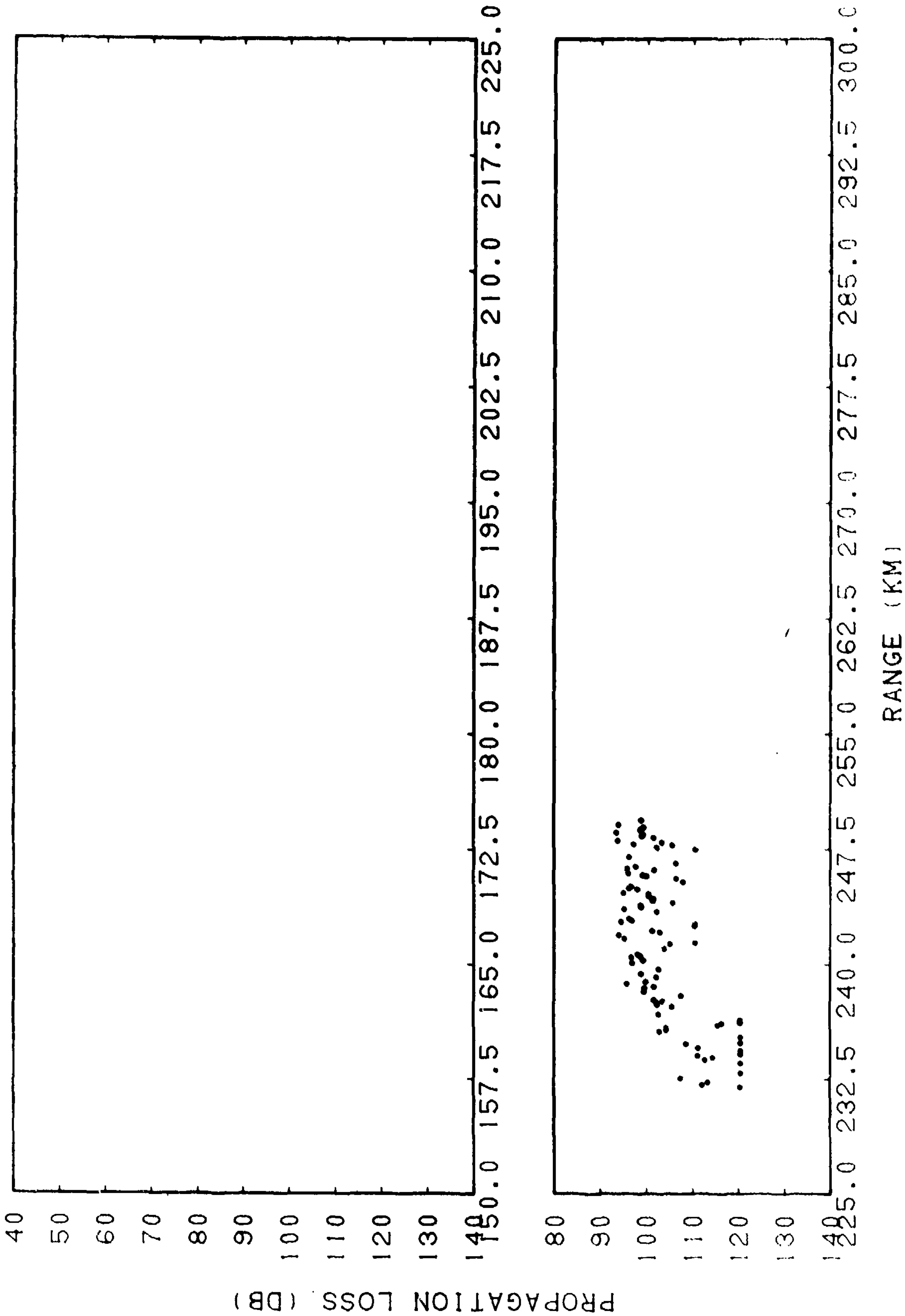
(C) Figure IIE-11. LORAD Run 8D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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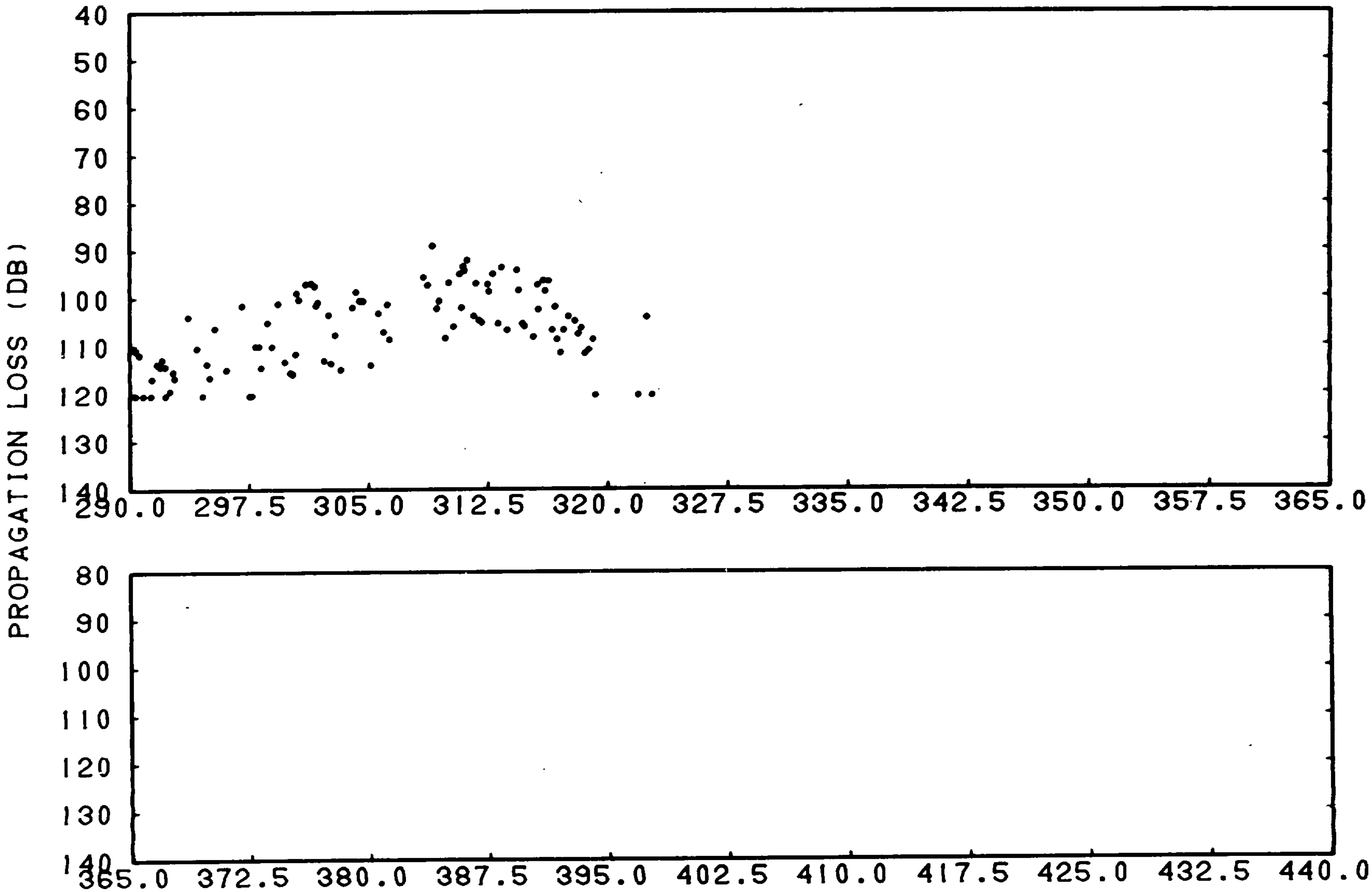
(C) Figure IIE-12. LORAD Run 10D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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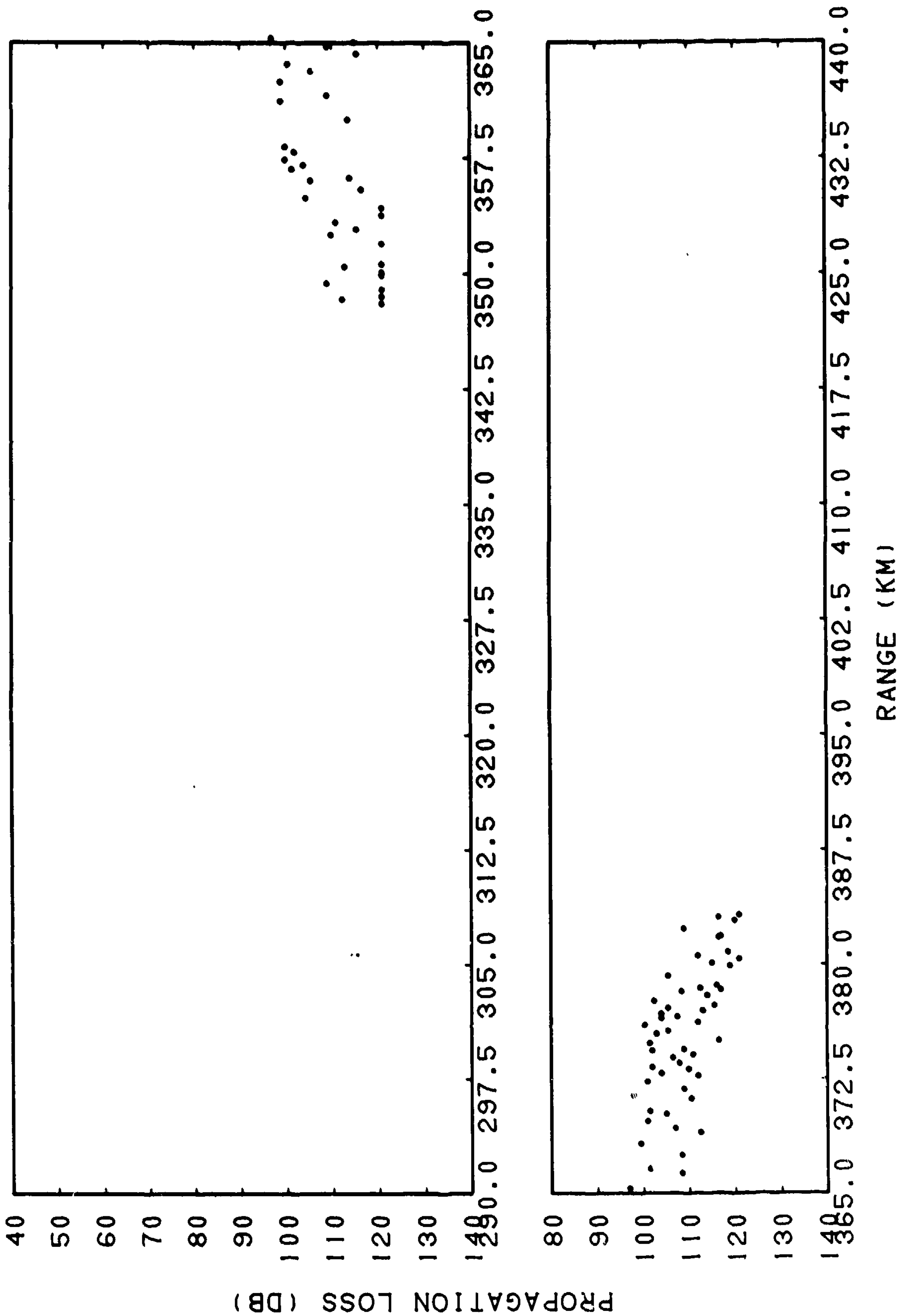
(C) Figure IIE-13. LORAD Run 12D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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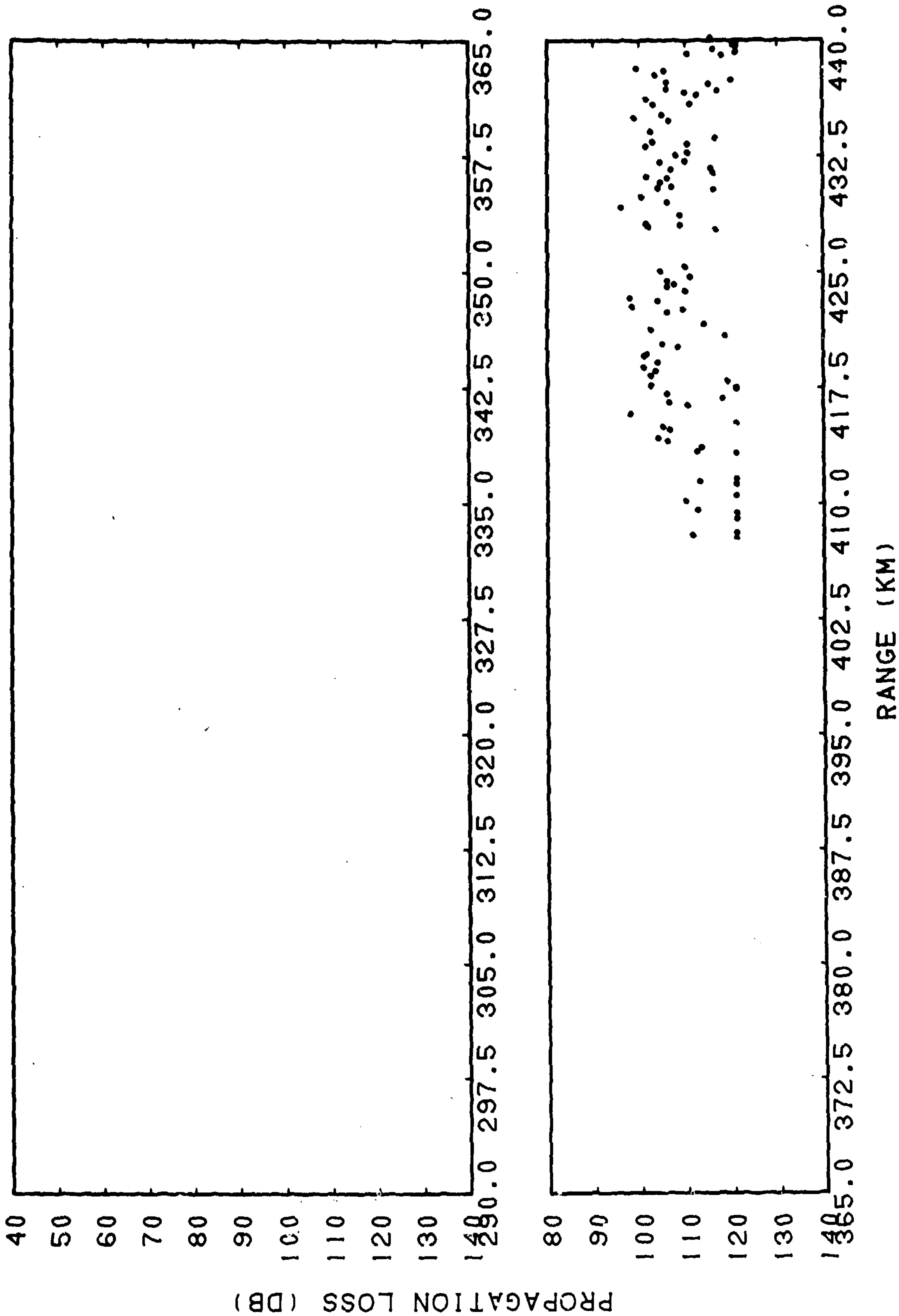
(C) Figure IIE-14. LORAD Run 14D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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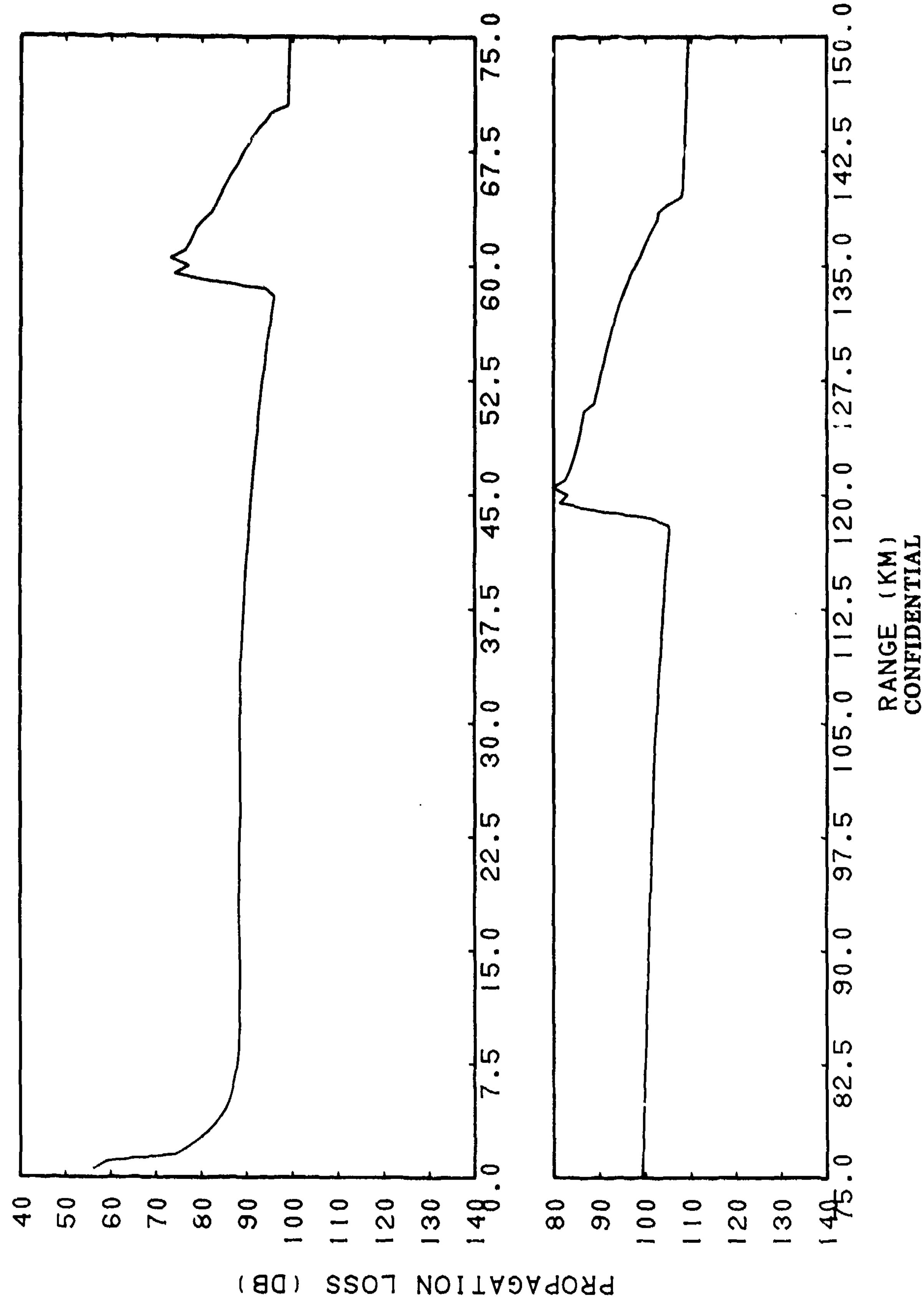
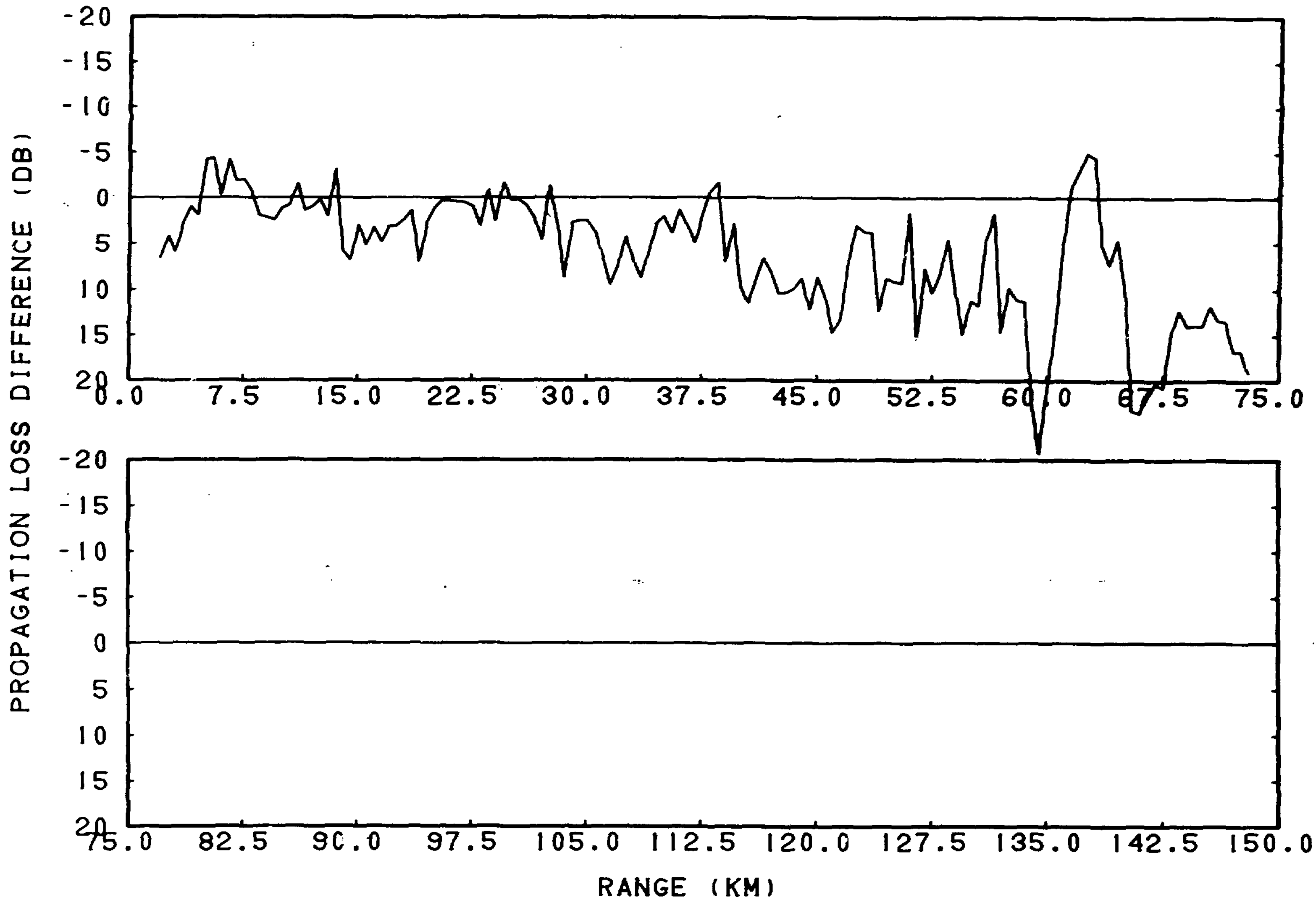
(C) *Figure IIE-15.* **LORAD Run 16D, *Frequency* = 0.53 *Kilohertz*, *Source Depth* = 15 *Meters*, *Receiver Depth* = 305 *Meters***



(C) Figure IIE-16. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 3S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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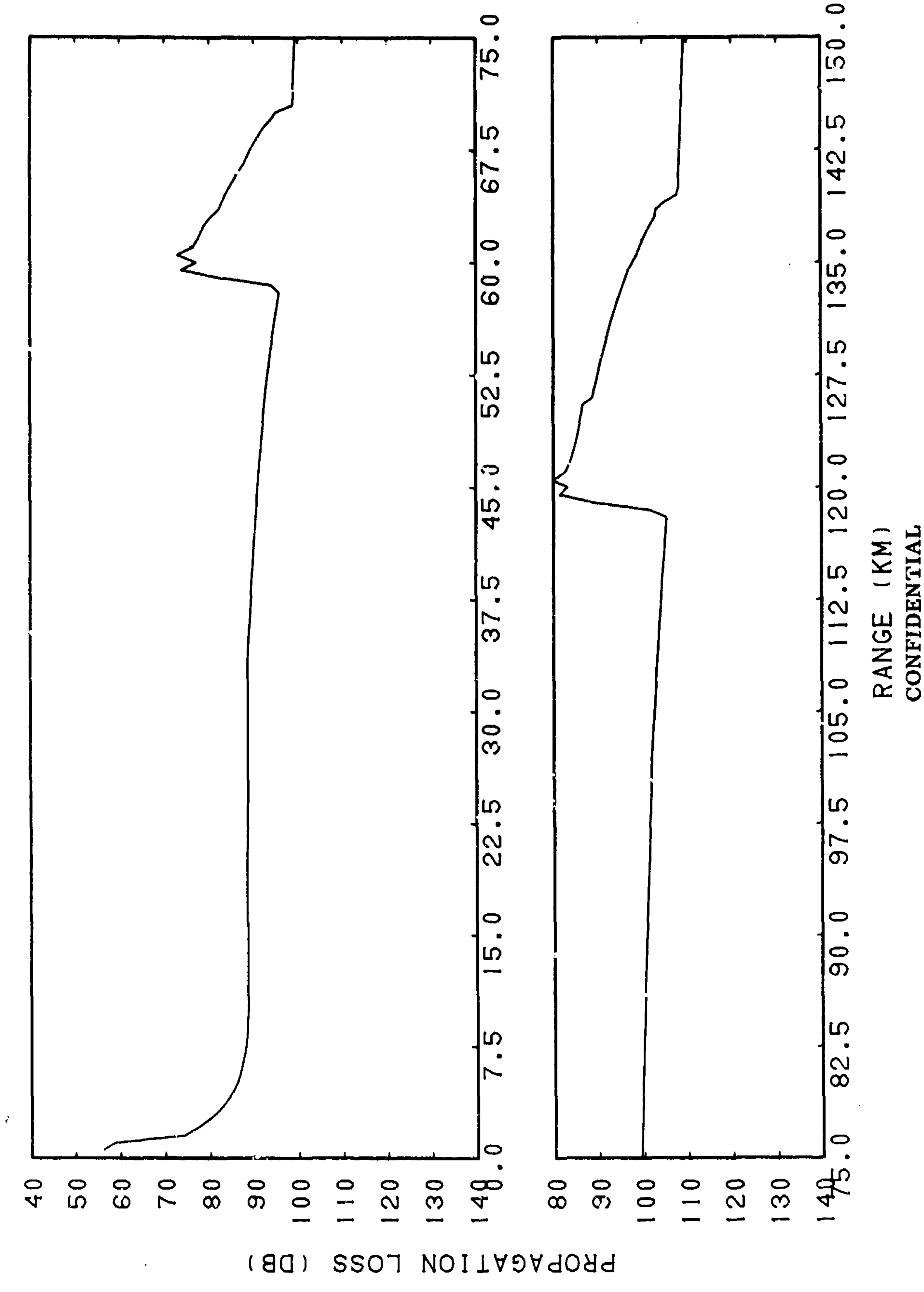
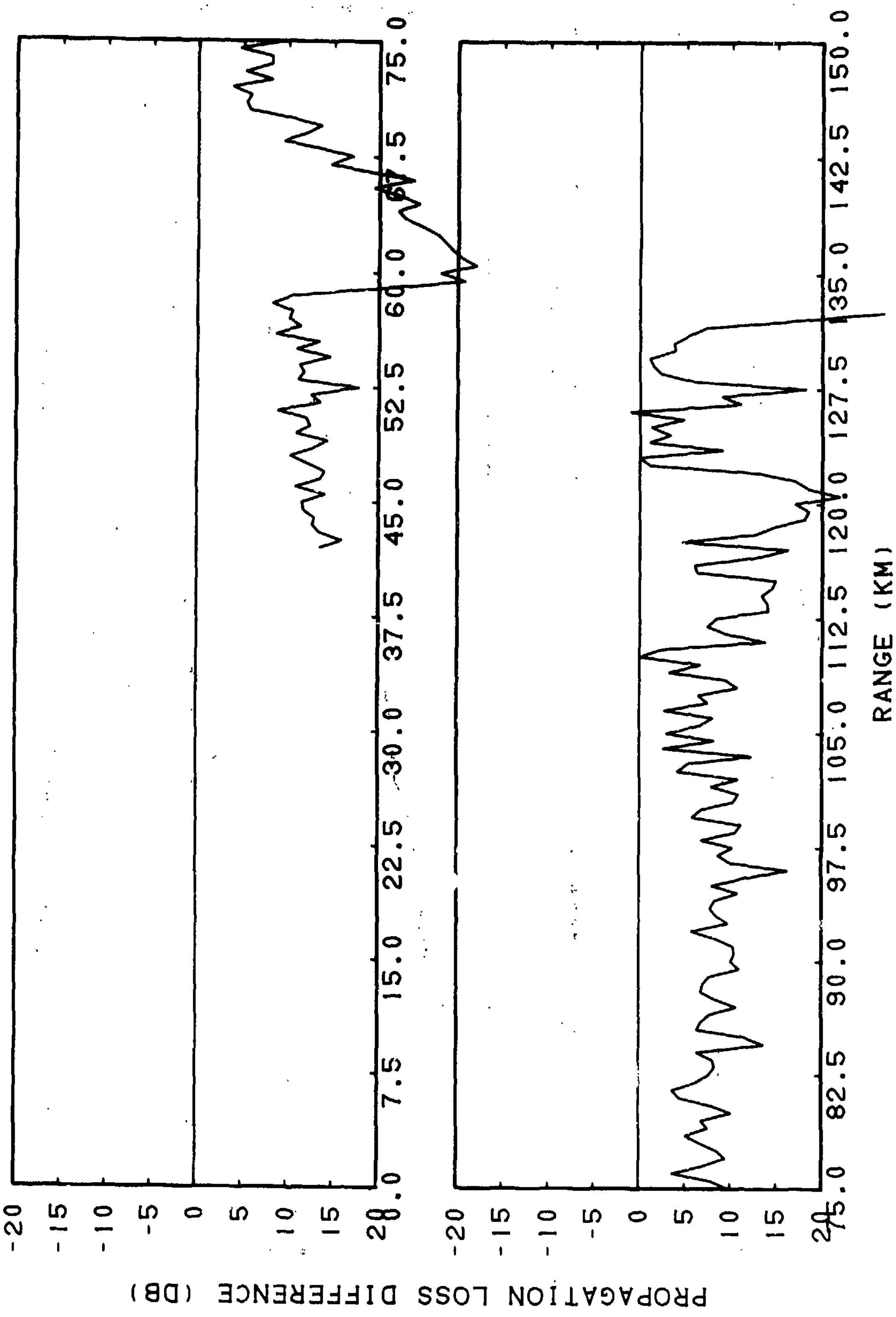
(C) Figure IIE-17. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 3S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters, Subtracted from LORAD Run 3S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



(C) Figure IIE-18. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 6S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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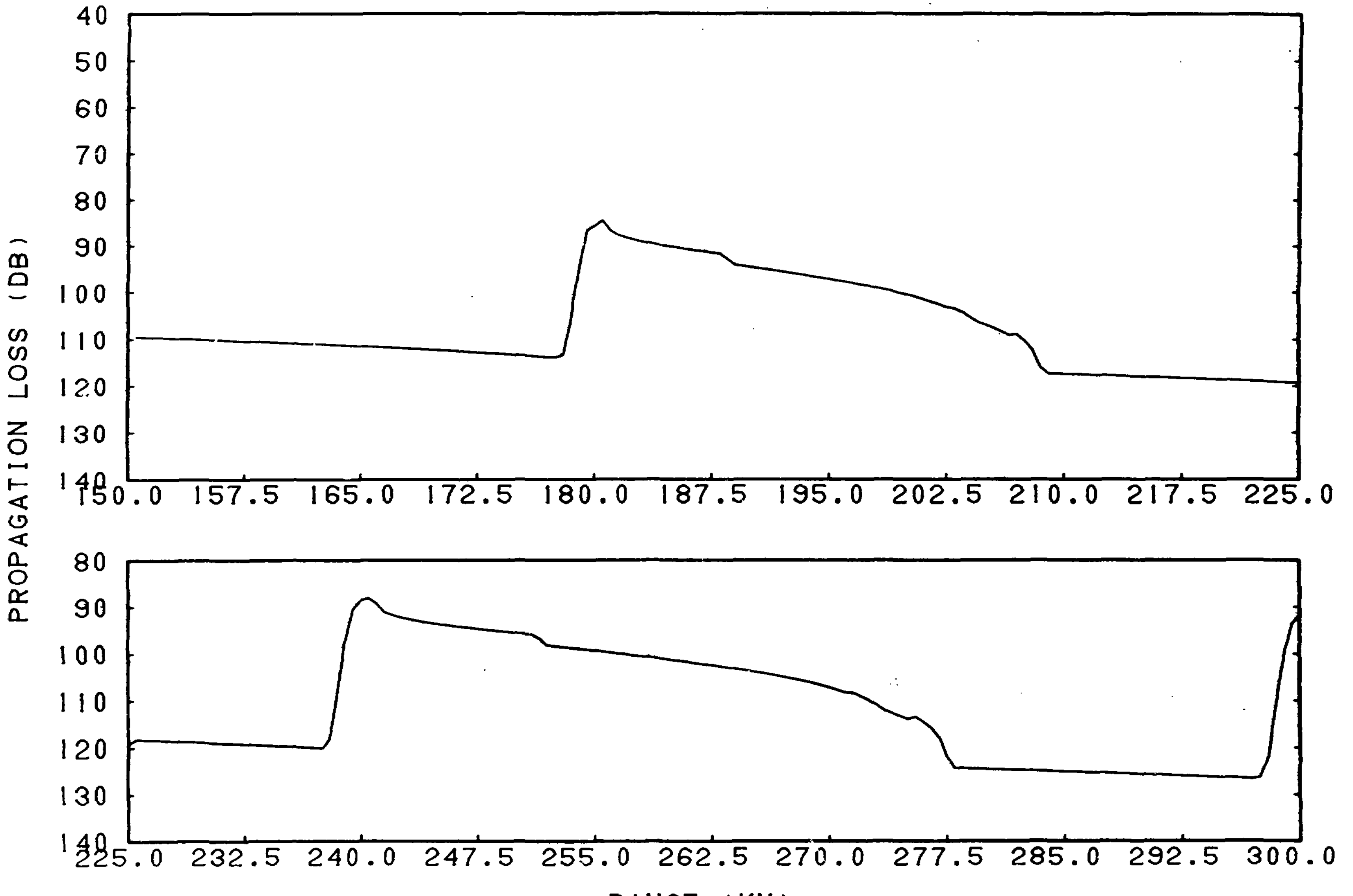
(C) Figure IIE-19. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 6S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters, Subtracted from LORAD Run 6S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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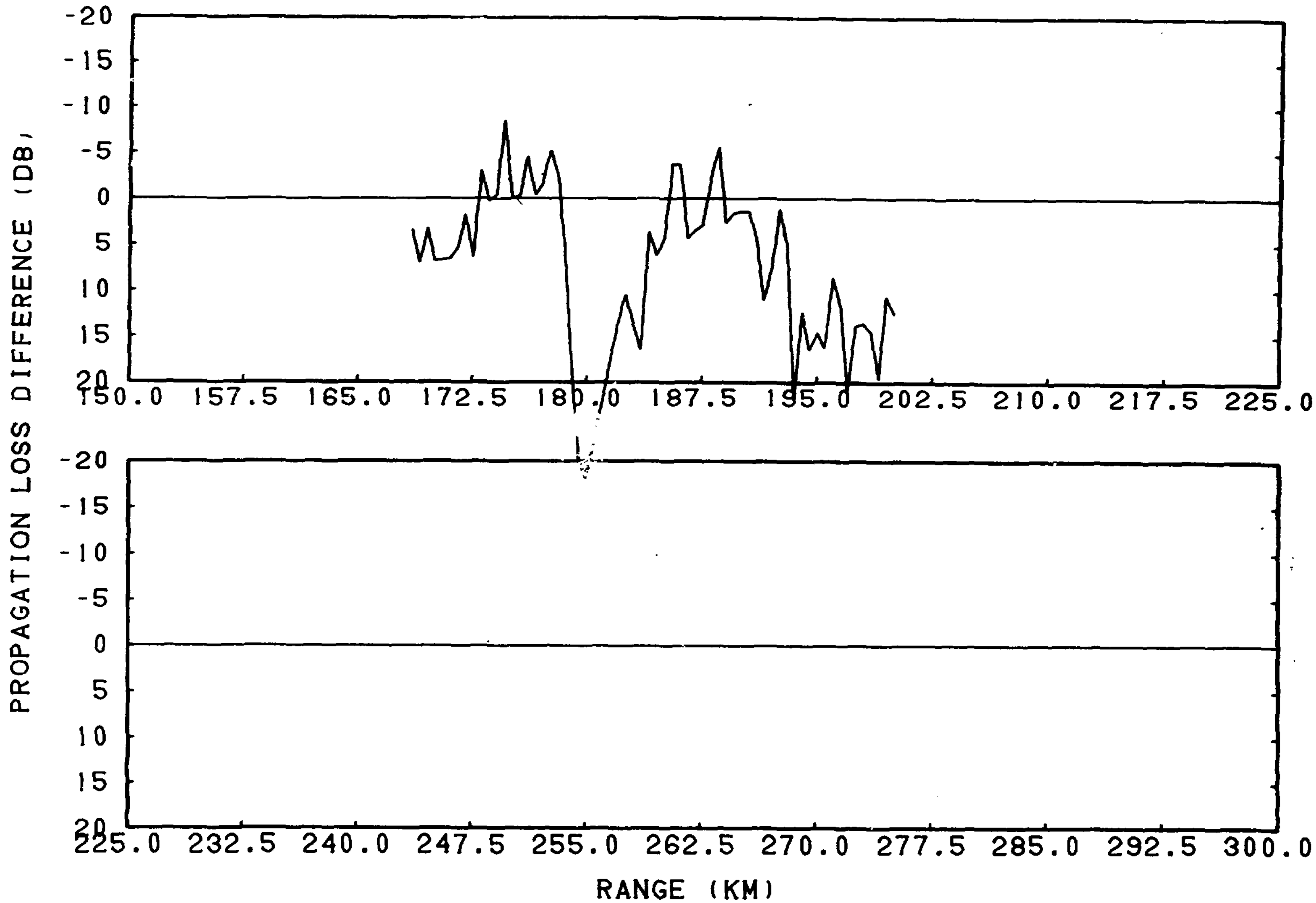
(C) Figure IIE-20. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 8S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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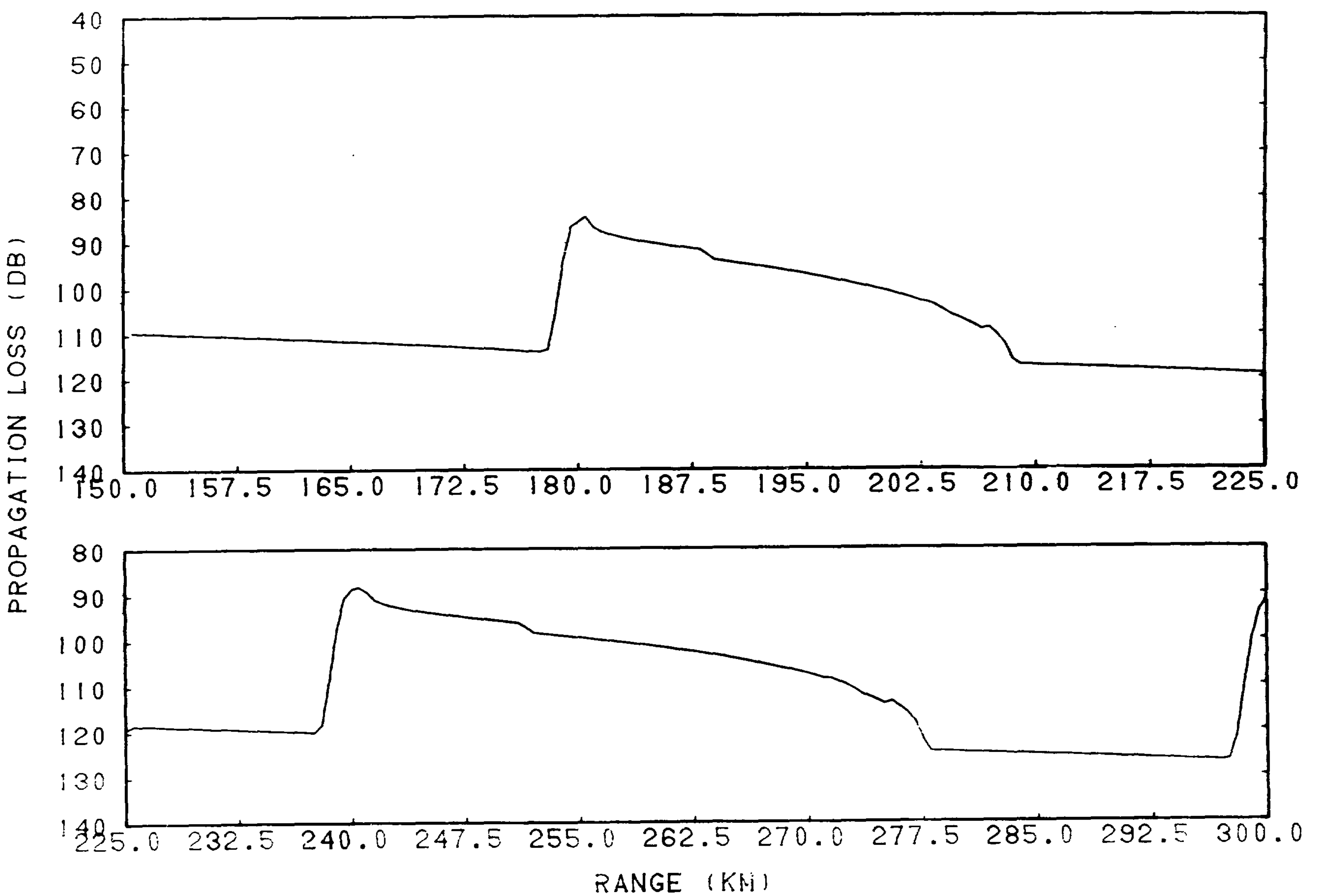
(C) Figure IIE-21. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 8S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters, Subtracted from LORAD Run 8S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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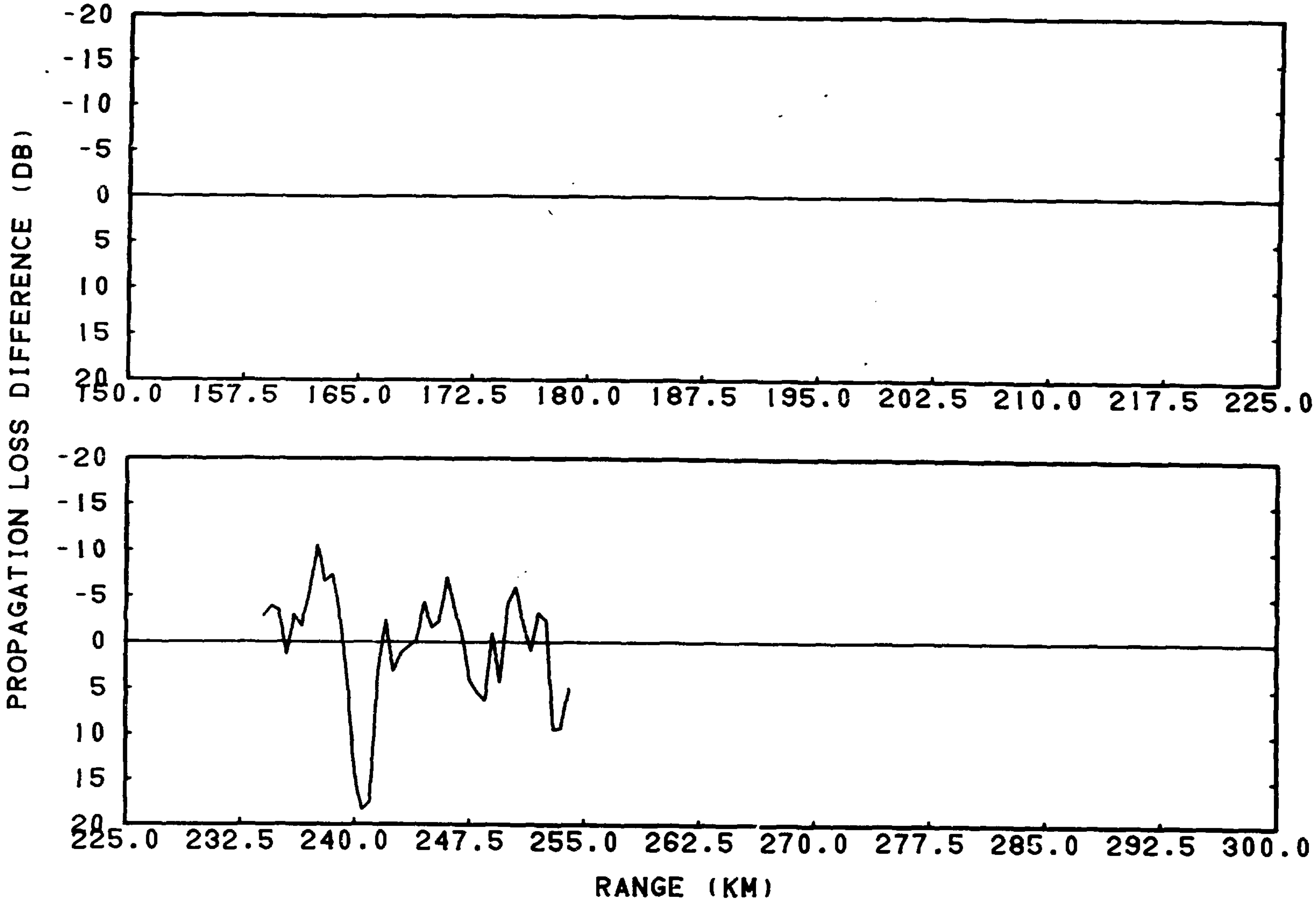
(C) Figure IIE-22. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 10S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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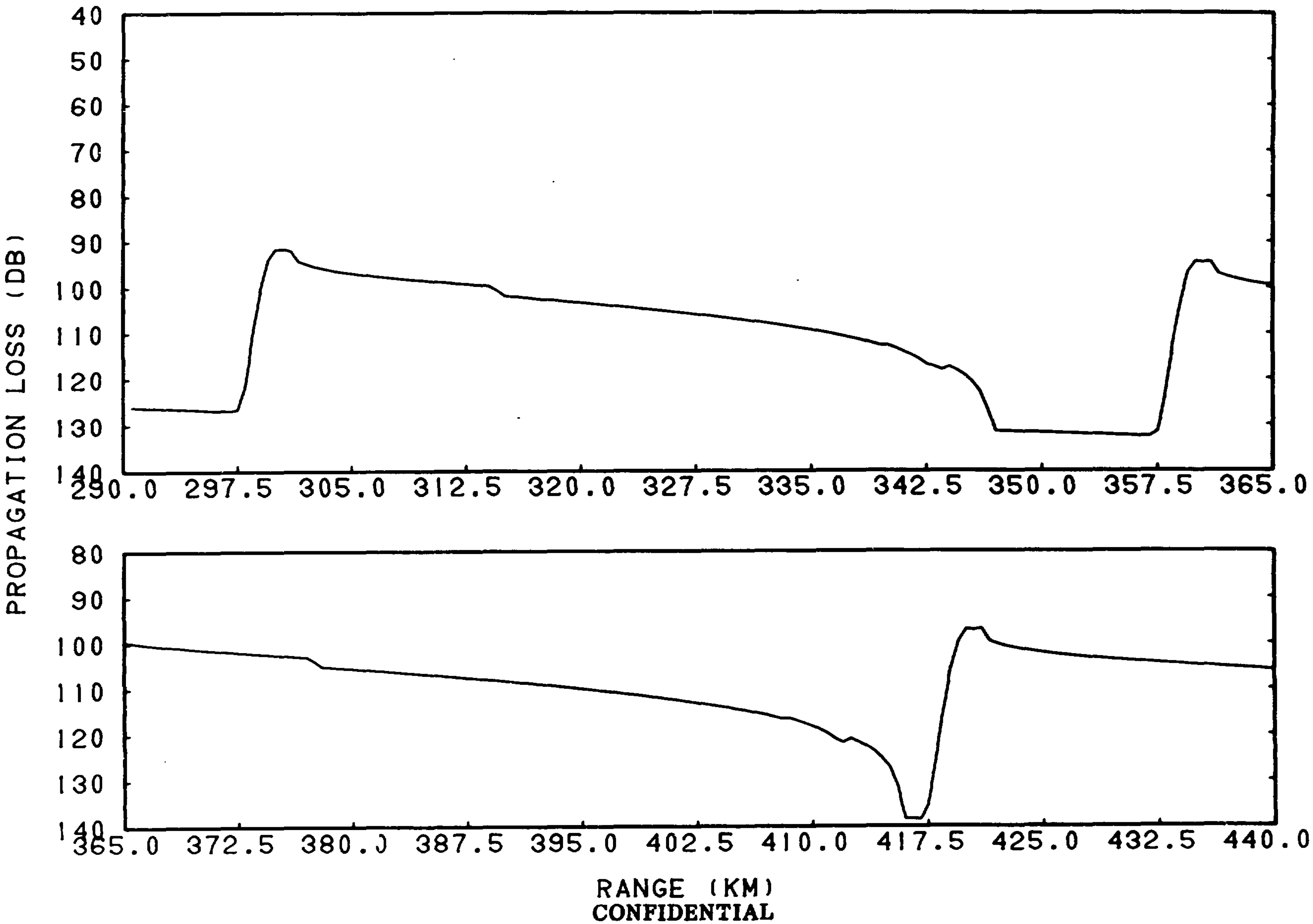
(C) Figure IIE-23. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 10S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters, Subtracted from LORAD Run 10 S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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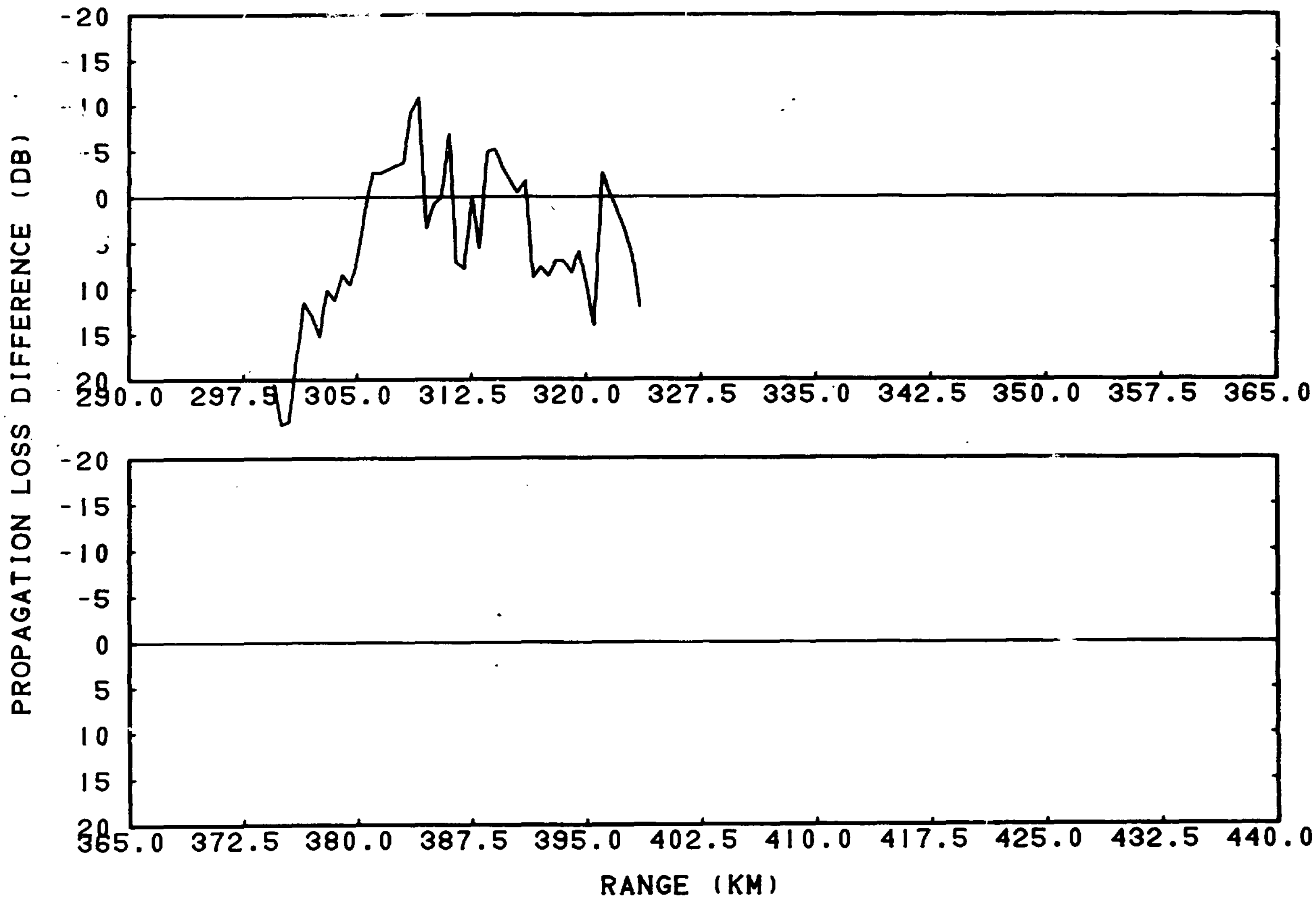
(C) Figure IIE-24. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 12S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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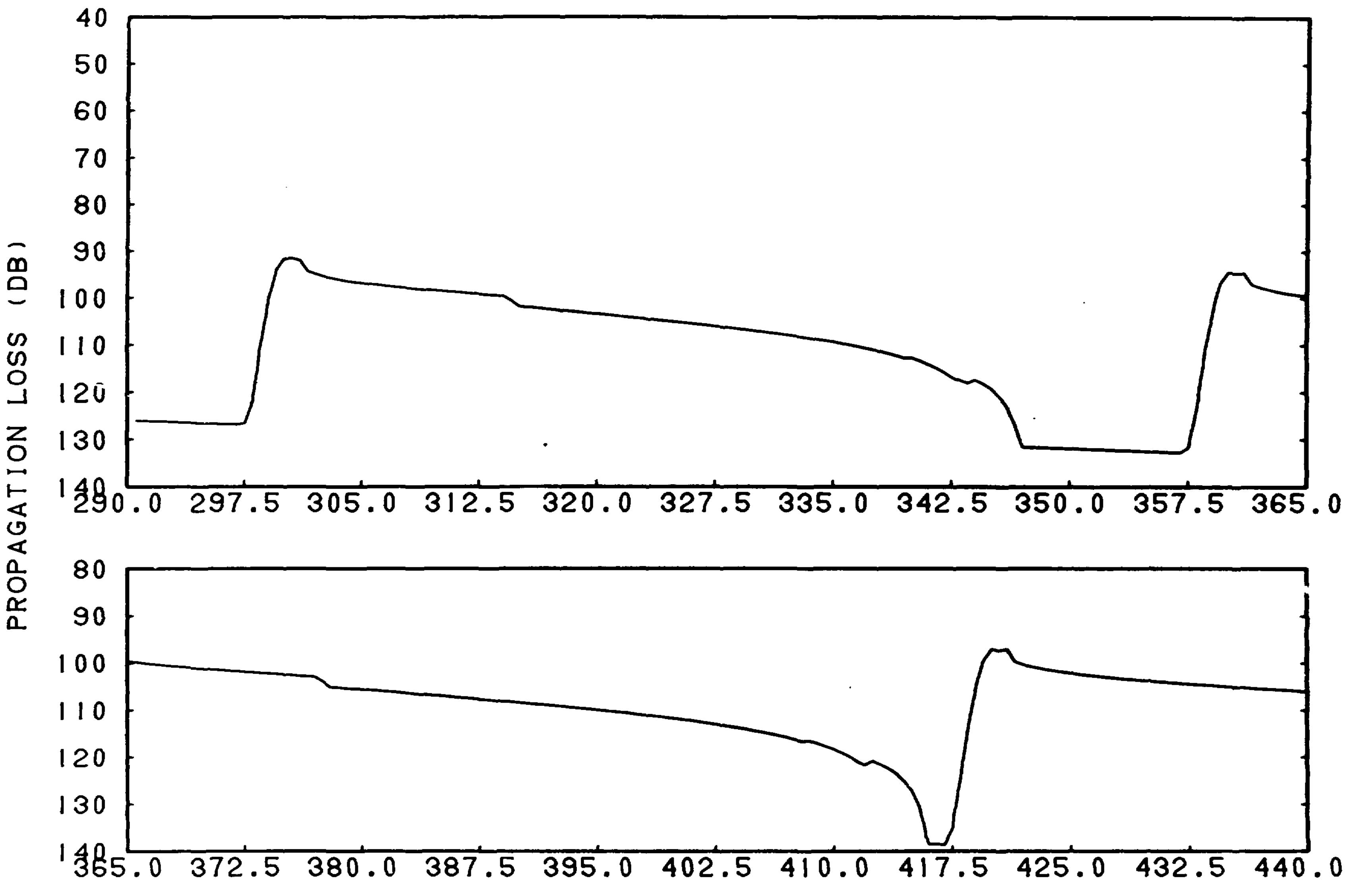
(C) Figure IIE-25. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 12S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 meters, Subtracted from LORAD Run 12S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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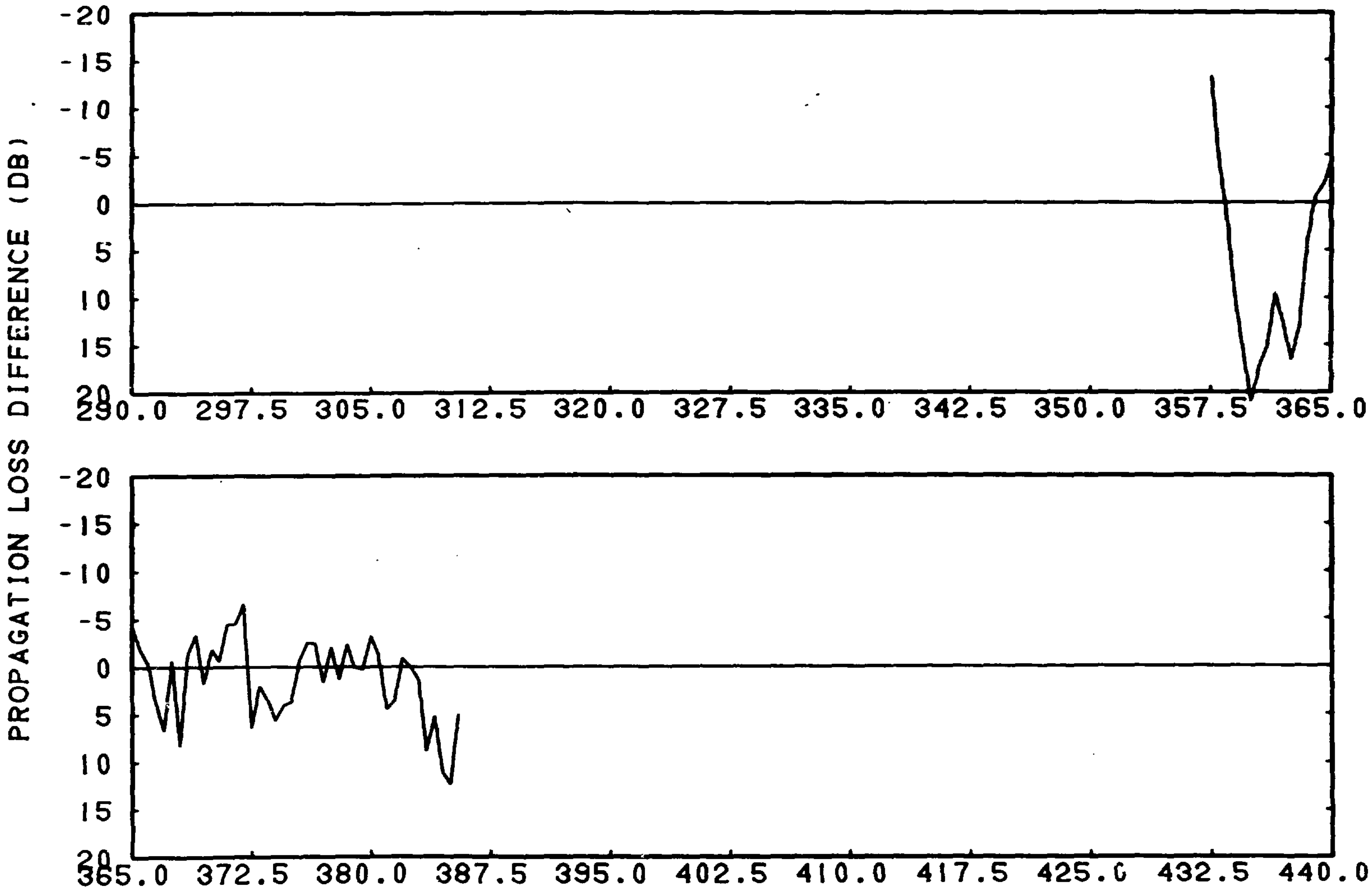
(C) Figure IIE-26. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 14S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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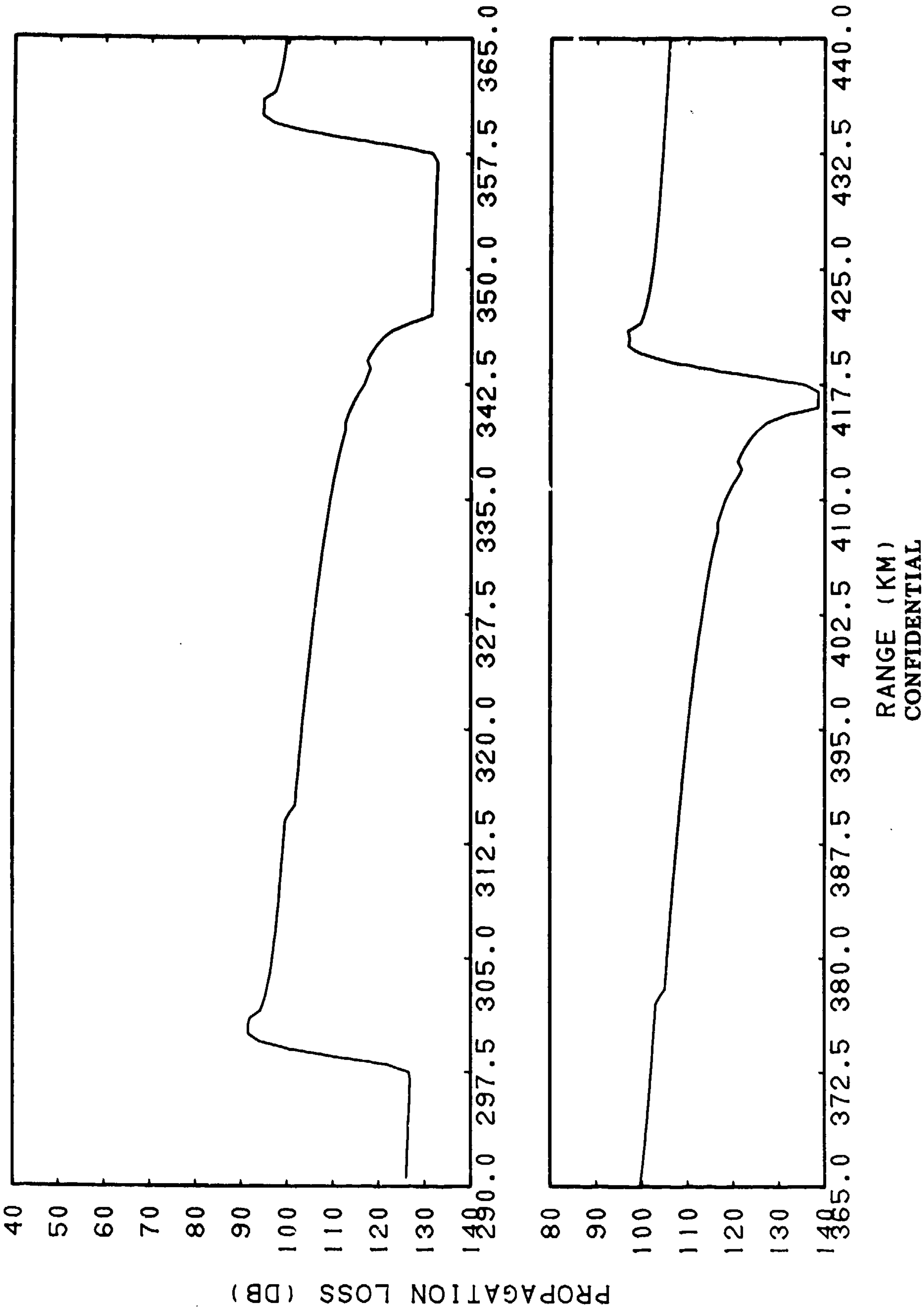
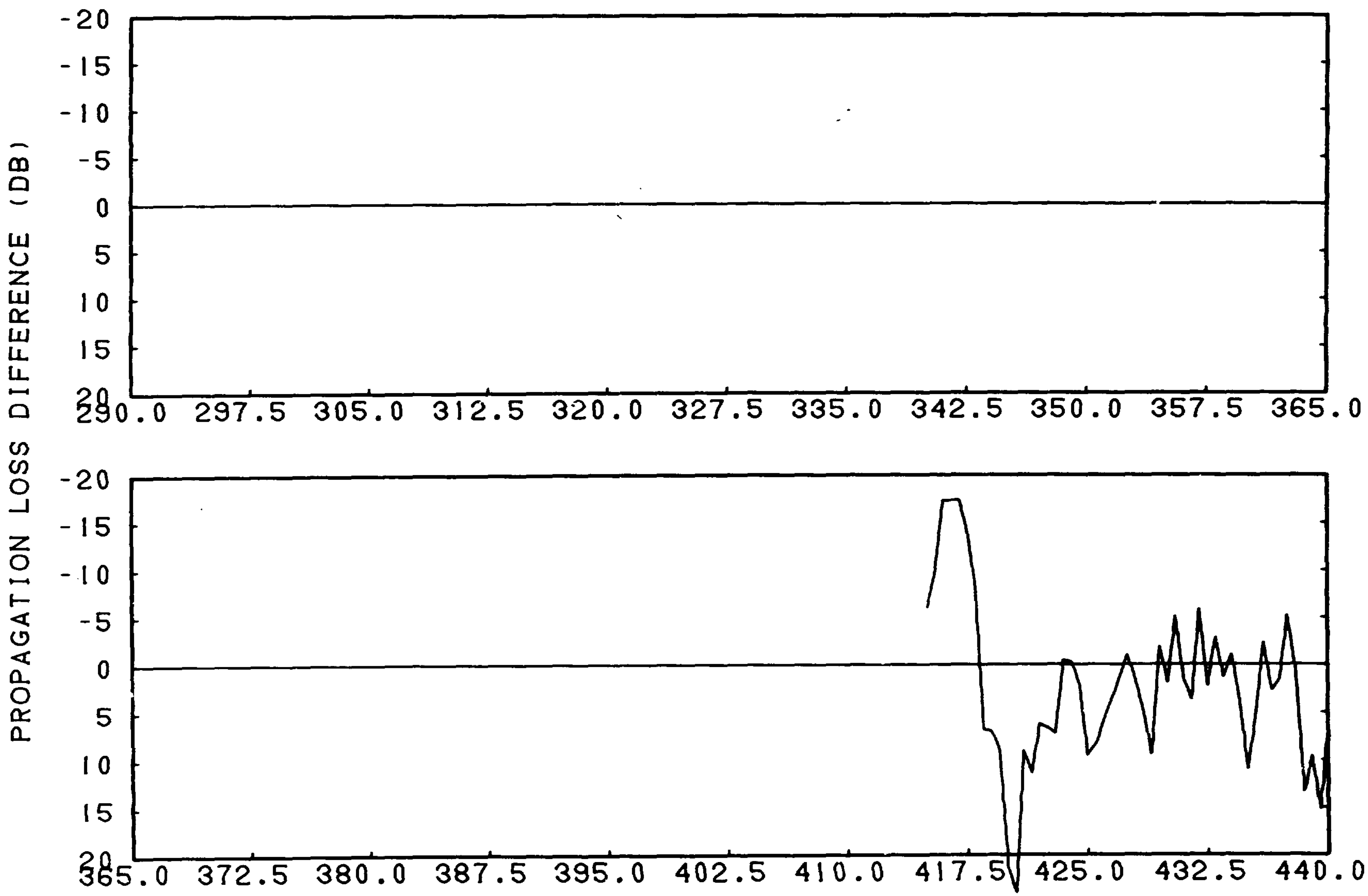
(C) Figure IIE-27. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 14S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters, Subtracted from LORAD Run 14S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



(C) Figure IIE-28. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 16S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth 30 Meters



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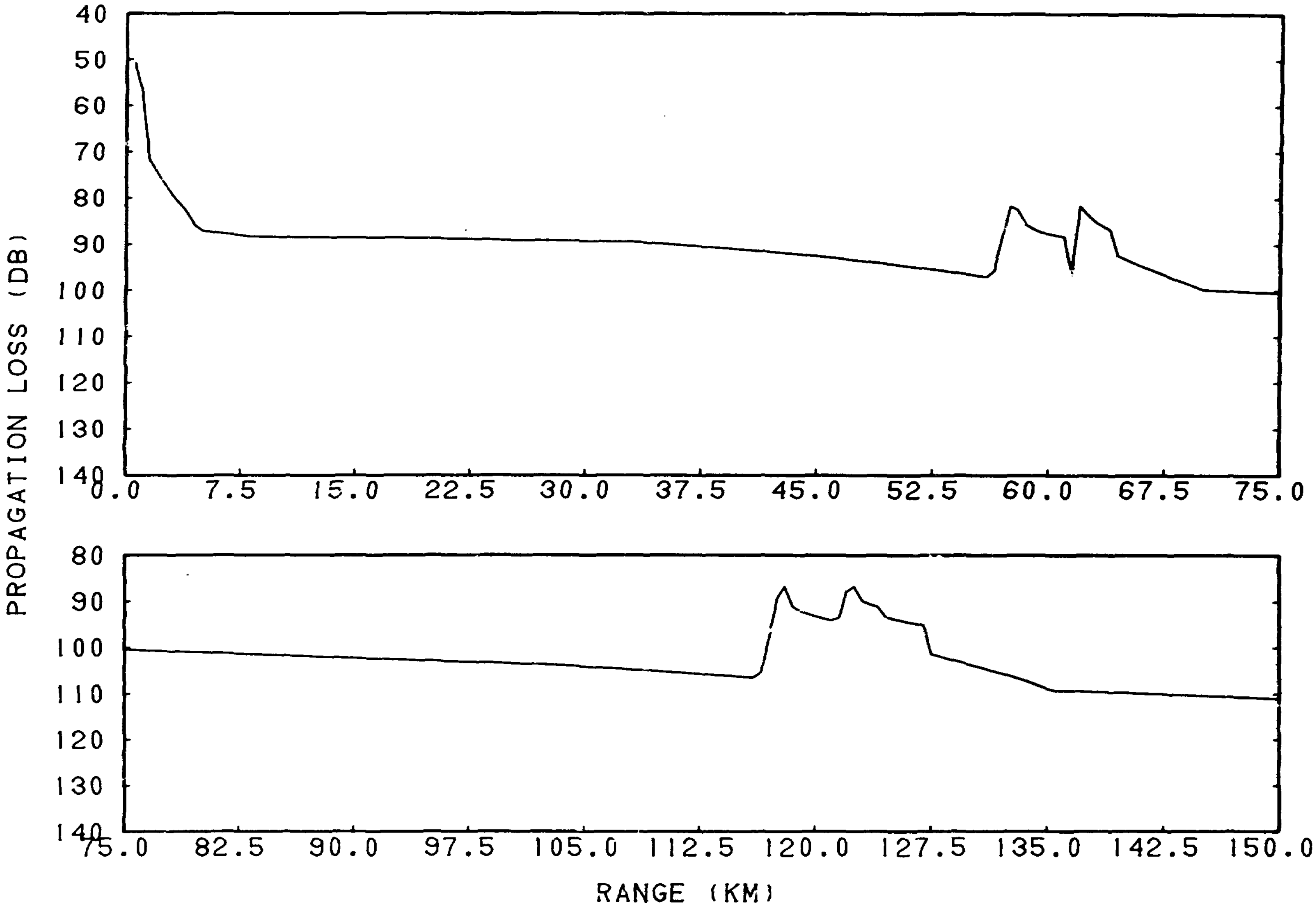
(C) Figure IIE-29. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 16S, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 30 Meters



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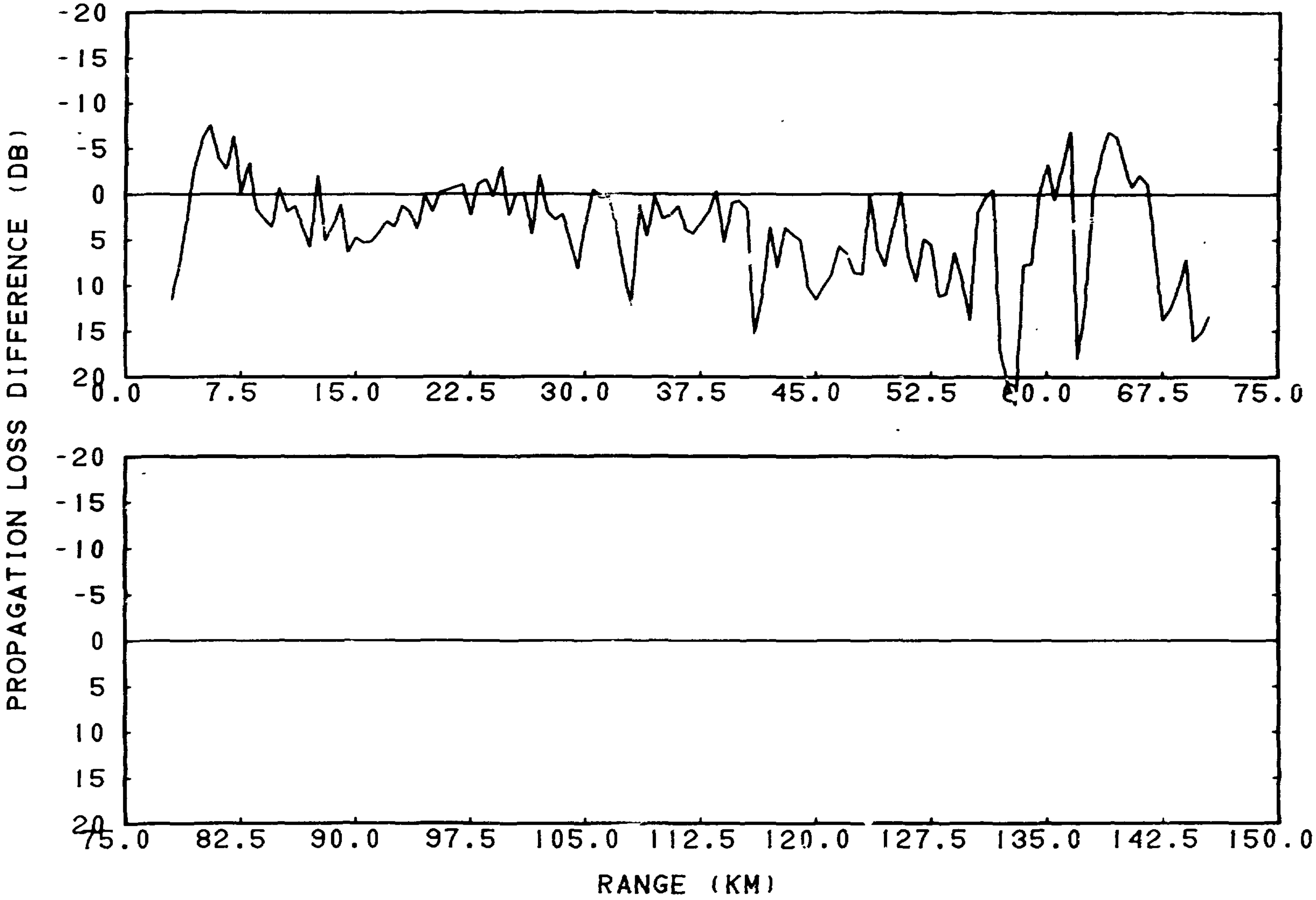
(C) Figure IIE-30. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 3D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth 305 Meters



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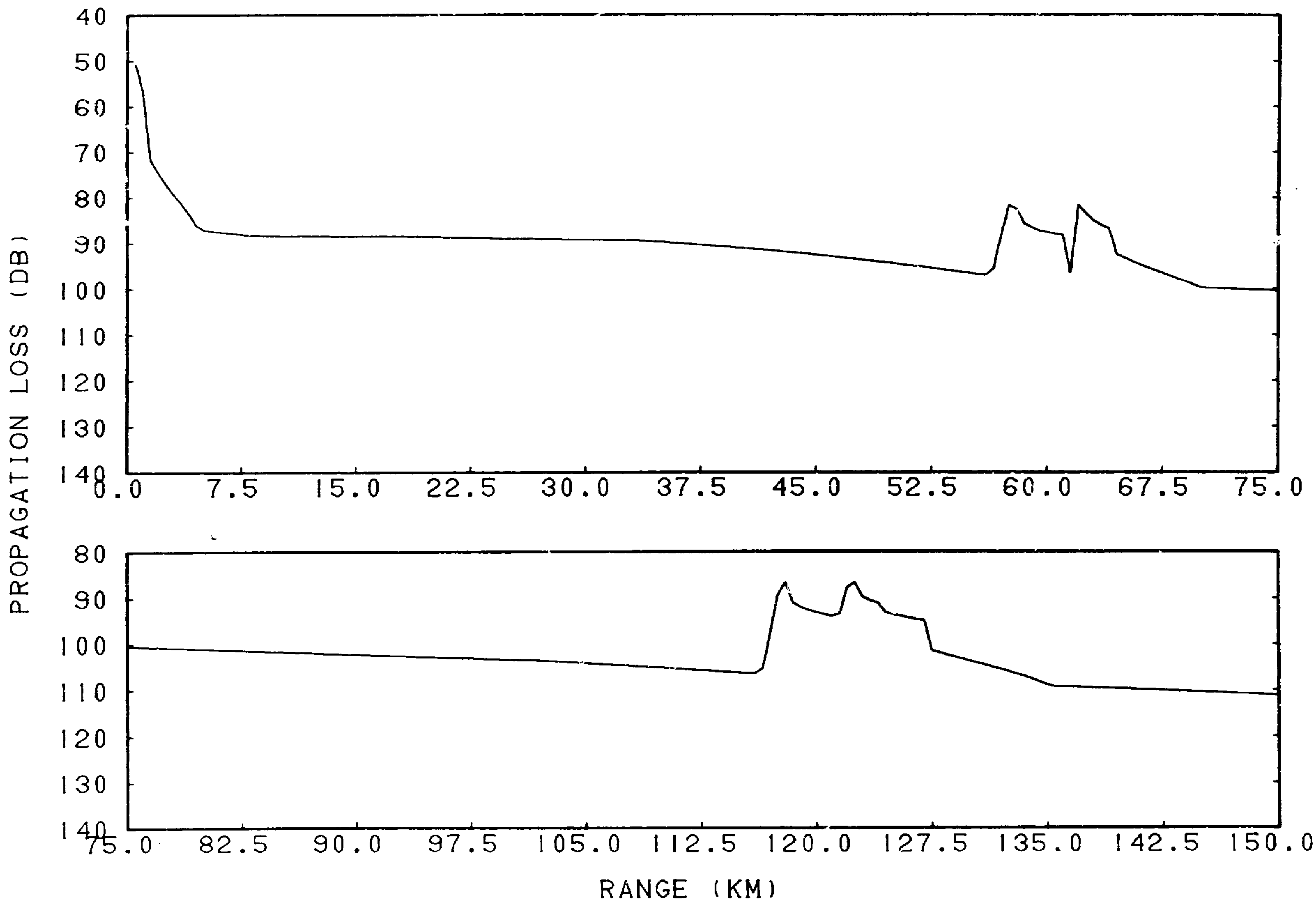
(C) Figure IIE-31. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 3D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters, Subtracted from ASTRAL Run 3D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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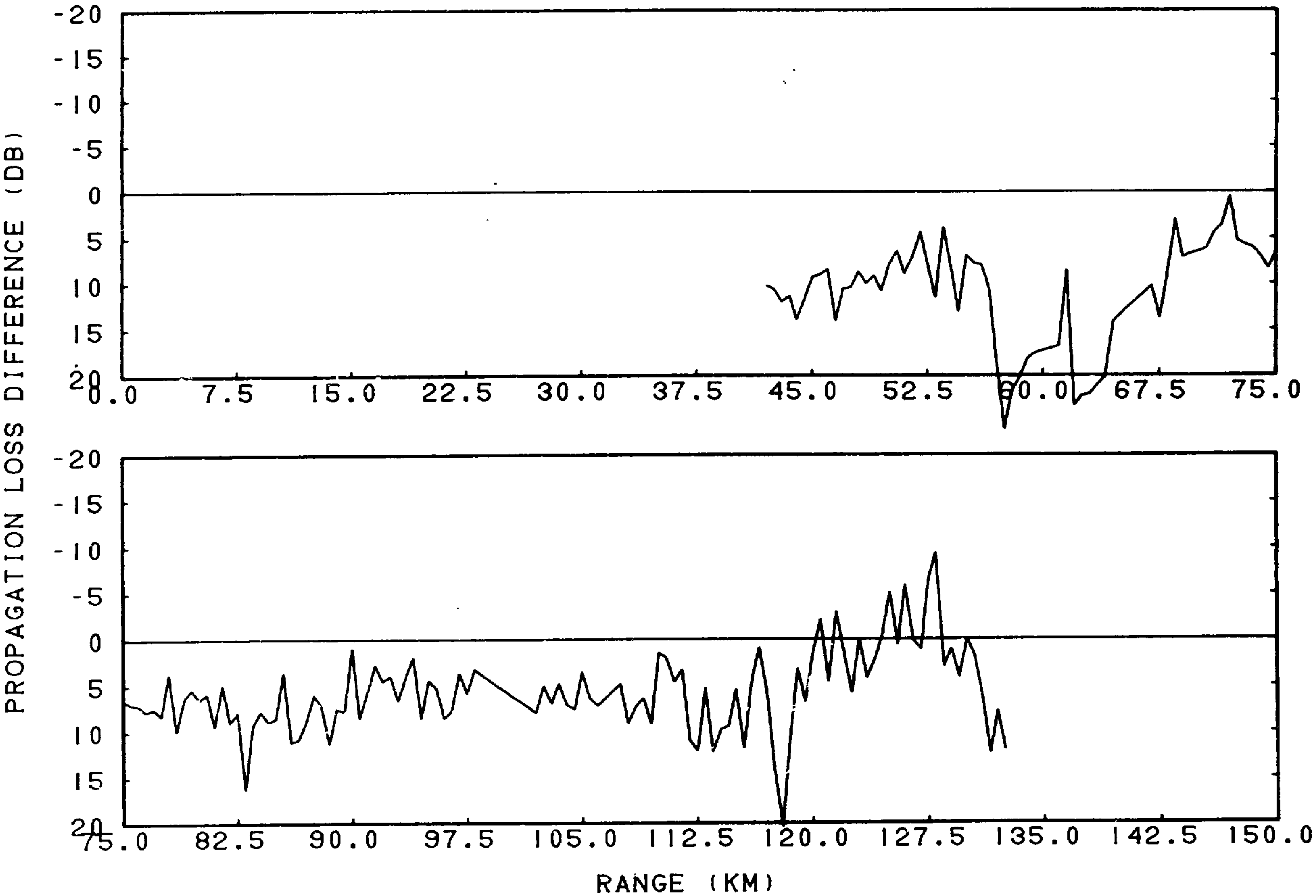
(C) Figure IIE-32. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 6D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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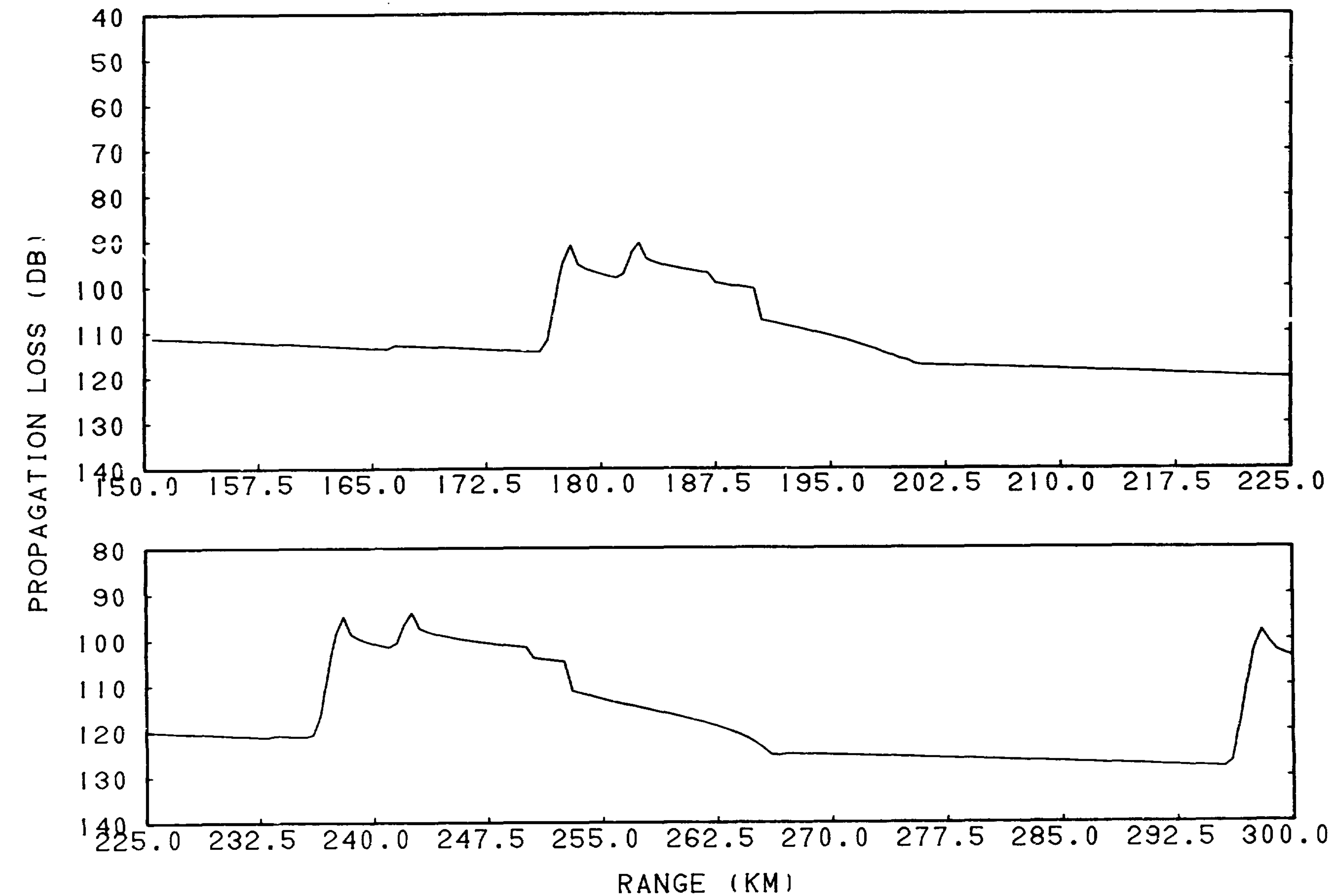
(C) Figure IIE-33. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 6D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters, Subtracted from LORAD Run 6D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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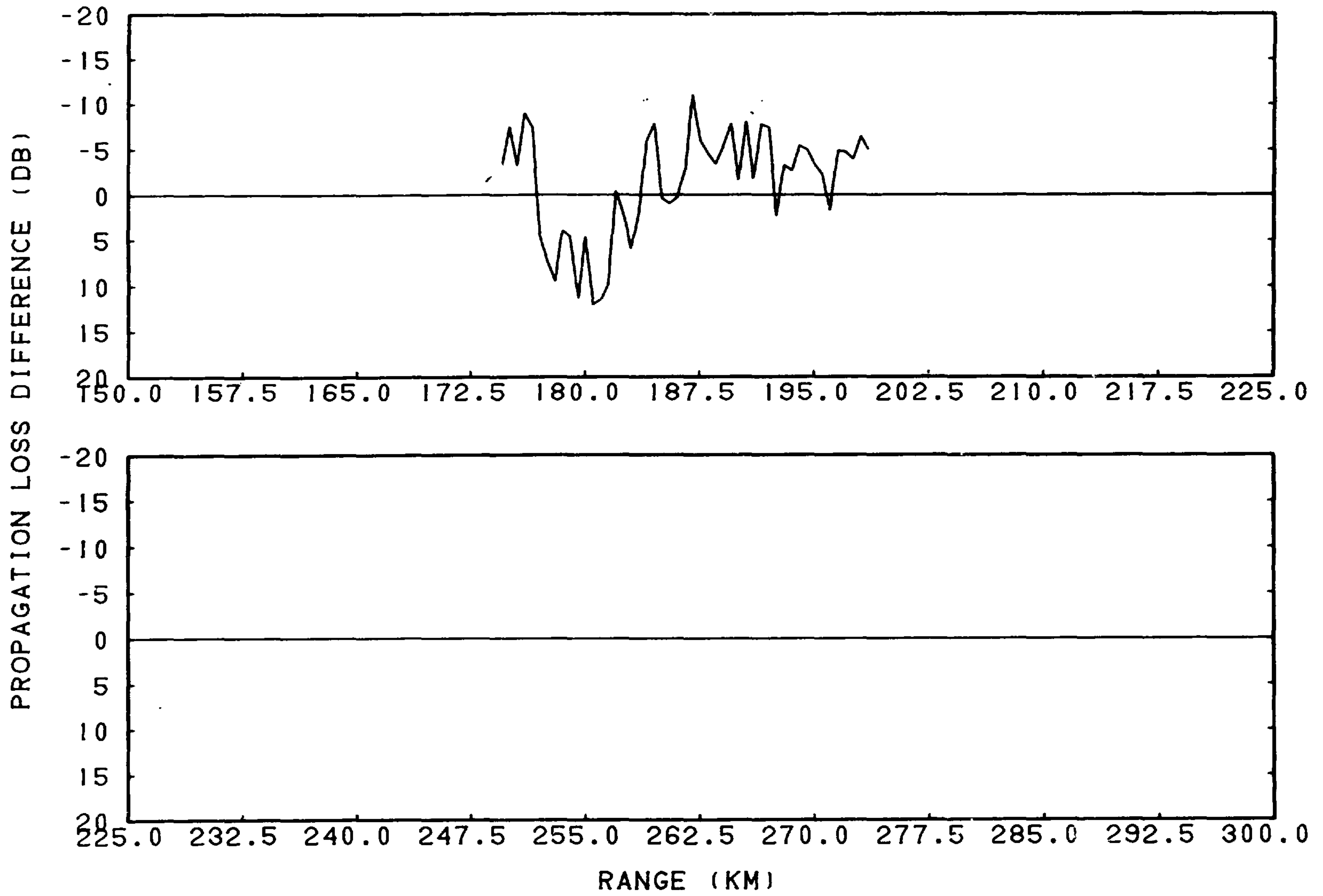
(C) Figure IIE-34. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 8D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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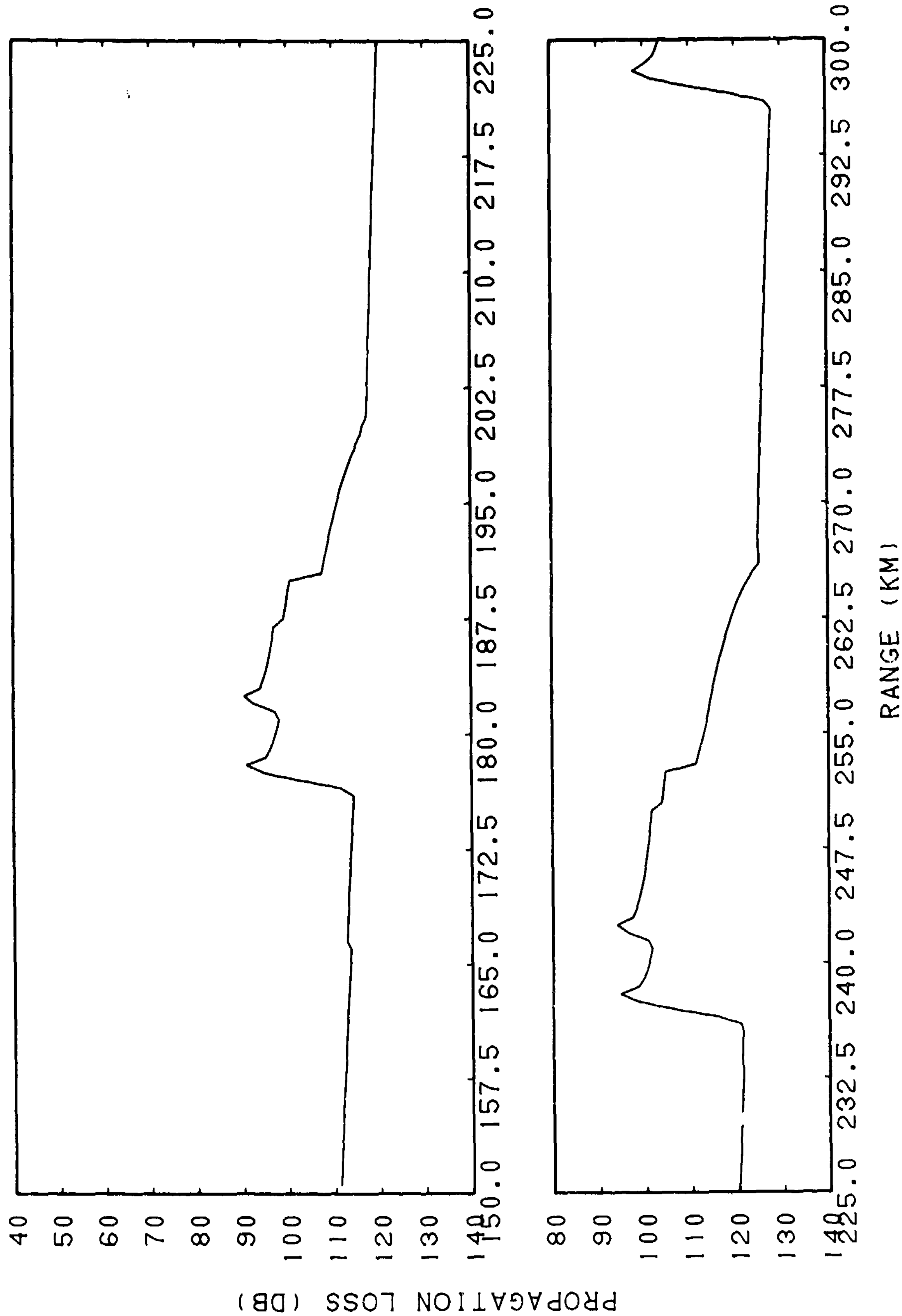
(C) Figure IIE-35. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 8D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters, Subtracted from LORAD Run 8D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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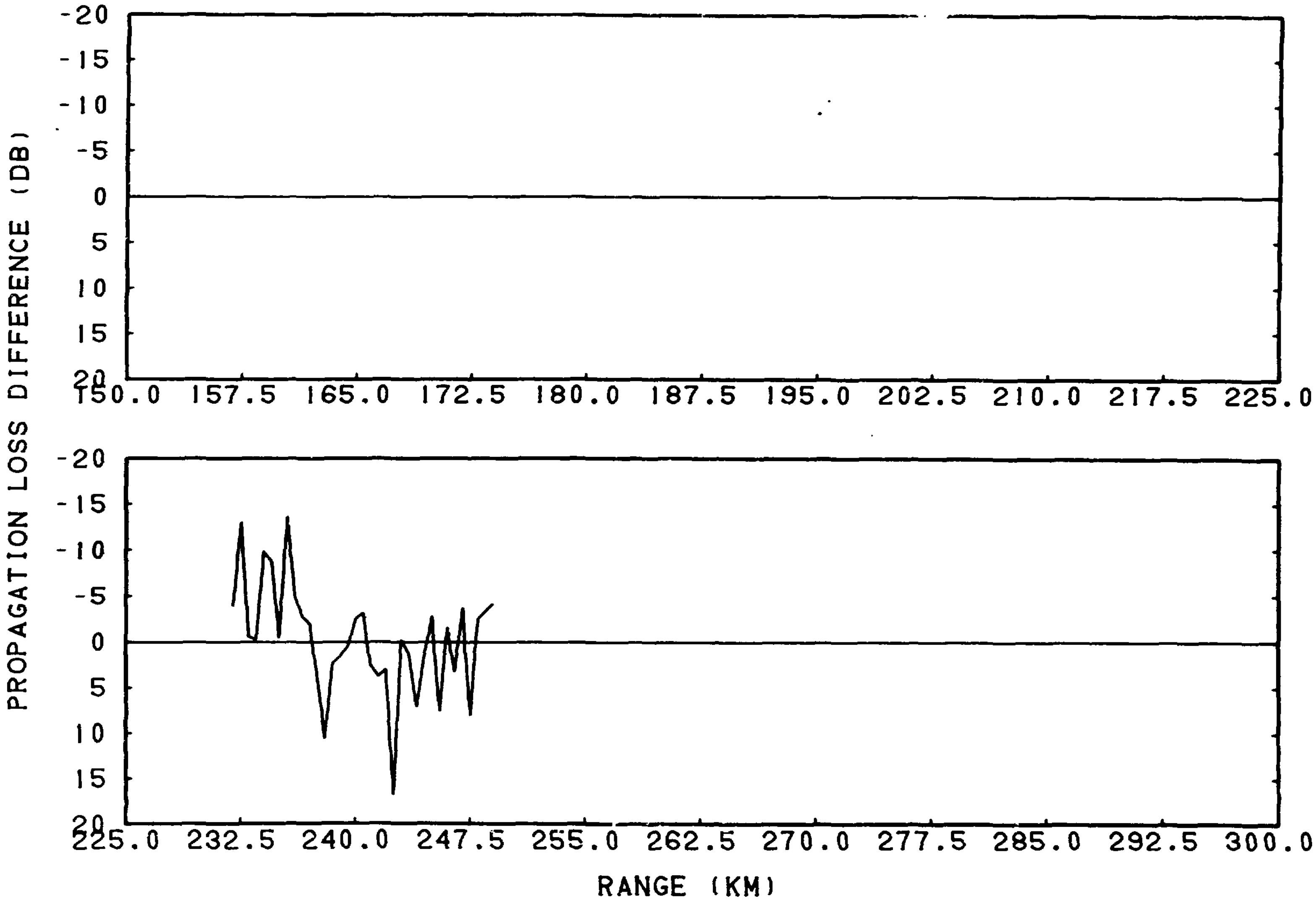
(C) Figure IIE-36. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 10D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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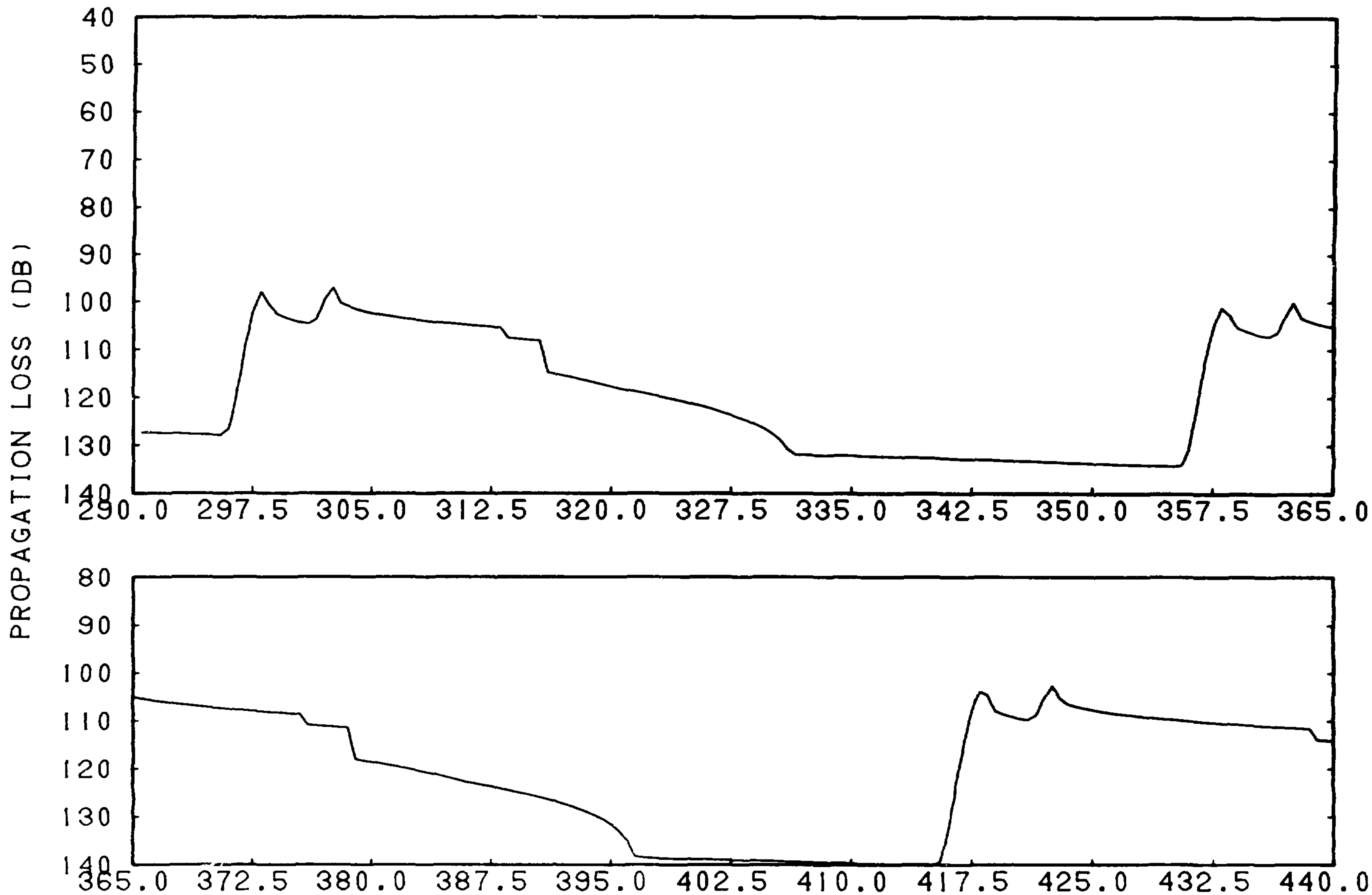
(C) Figure IIE-37. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 10D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters, Subtracted from LORAD Run 10D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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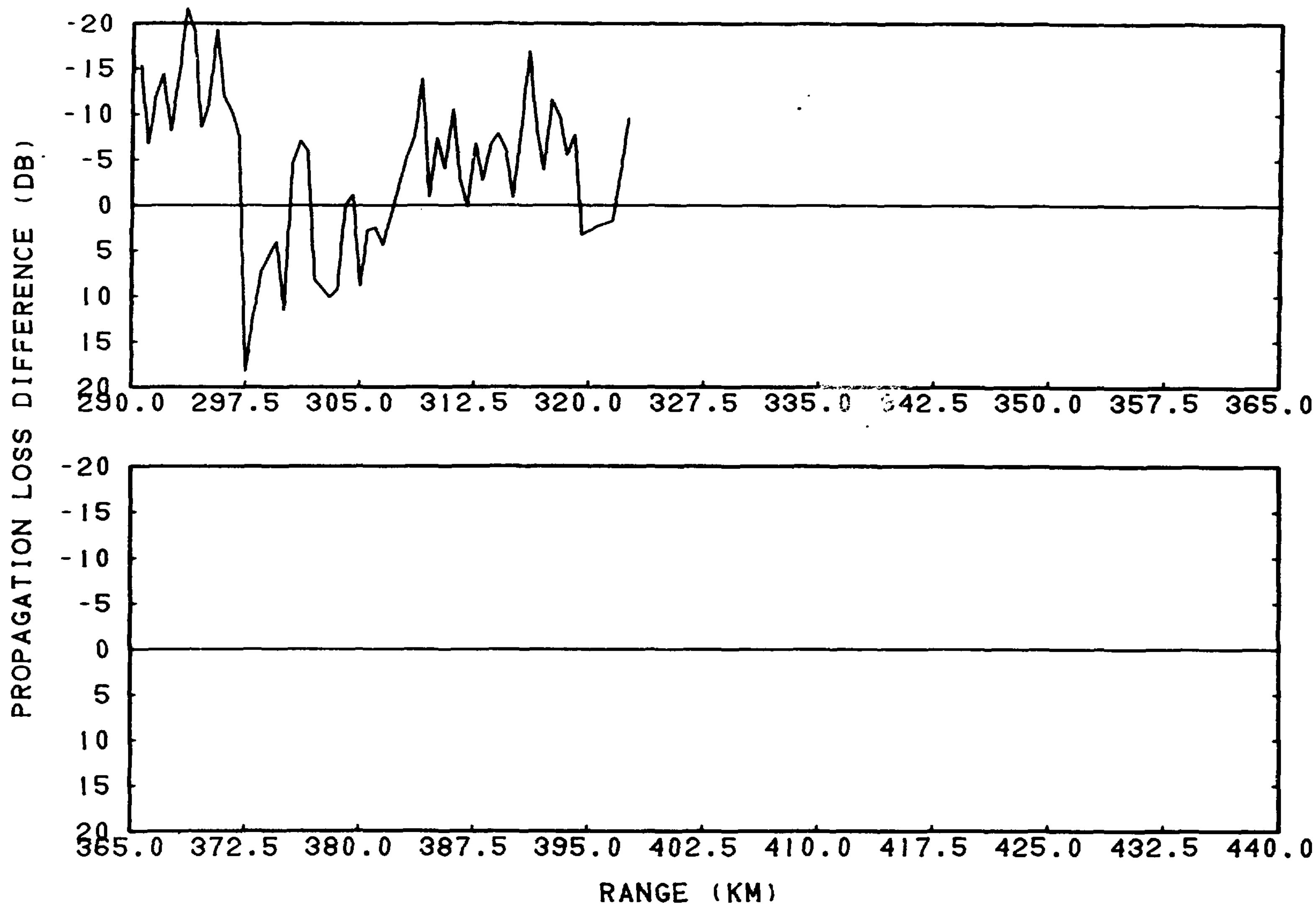
(C) Figure IIE-38. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 12D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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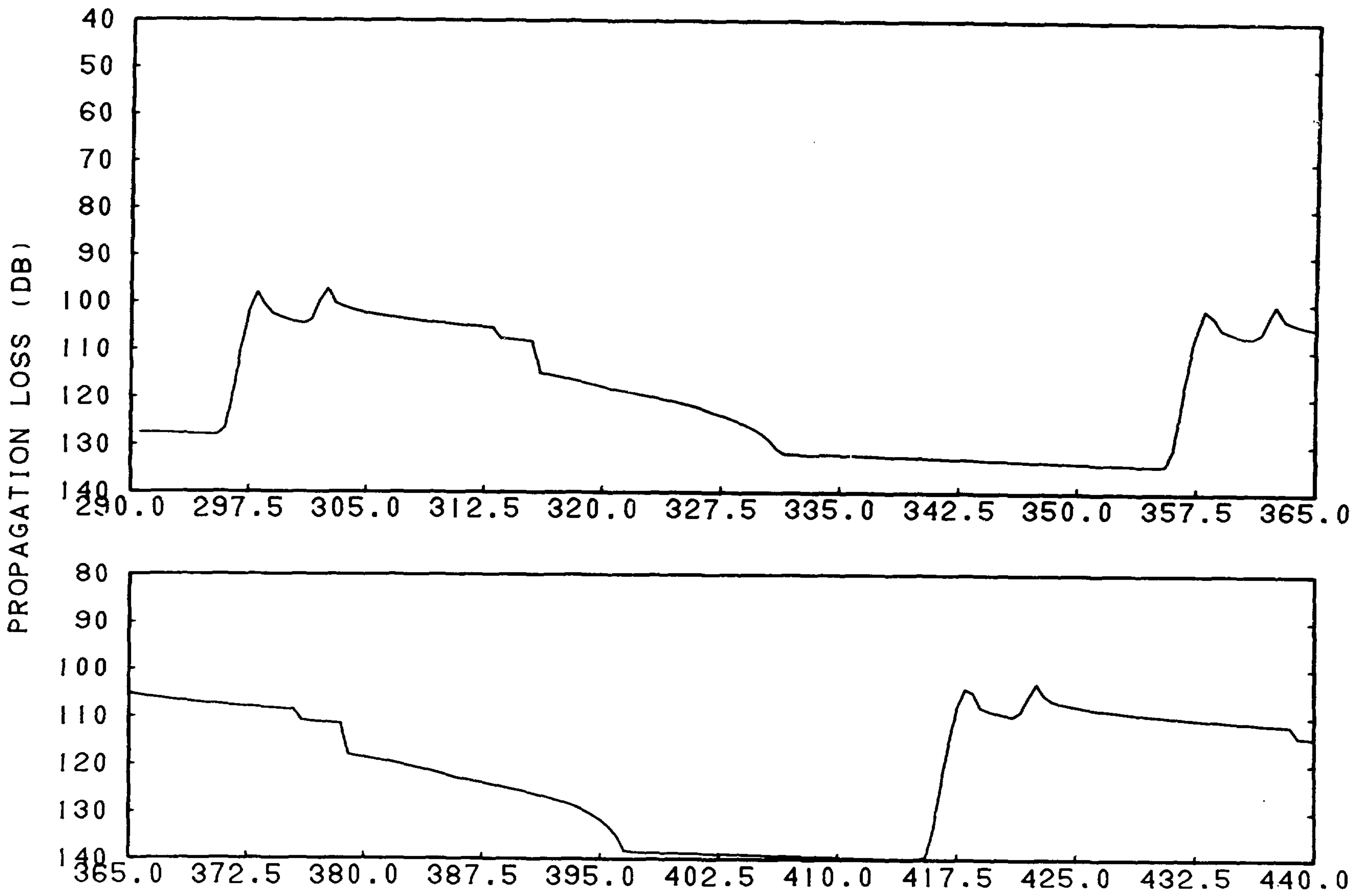
(C) Figure IIE-39. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 12D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters, Subtracted from LORAD Run 12D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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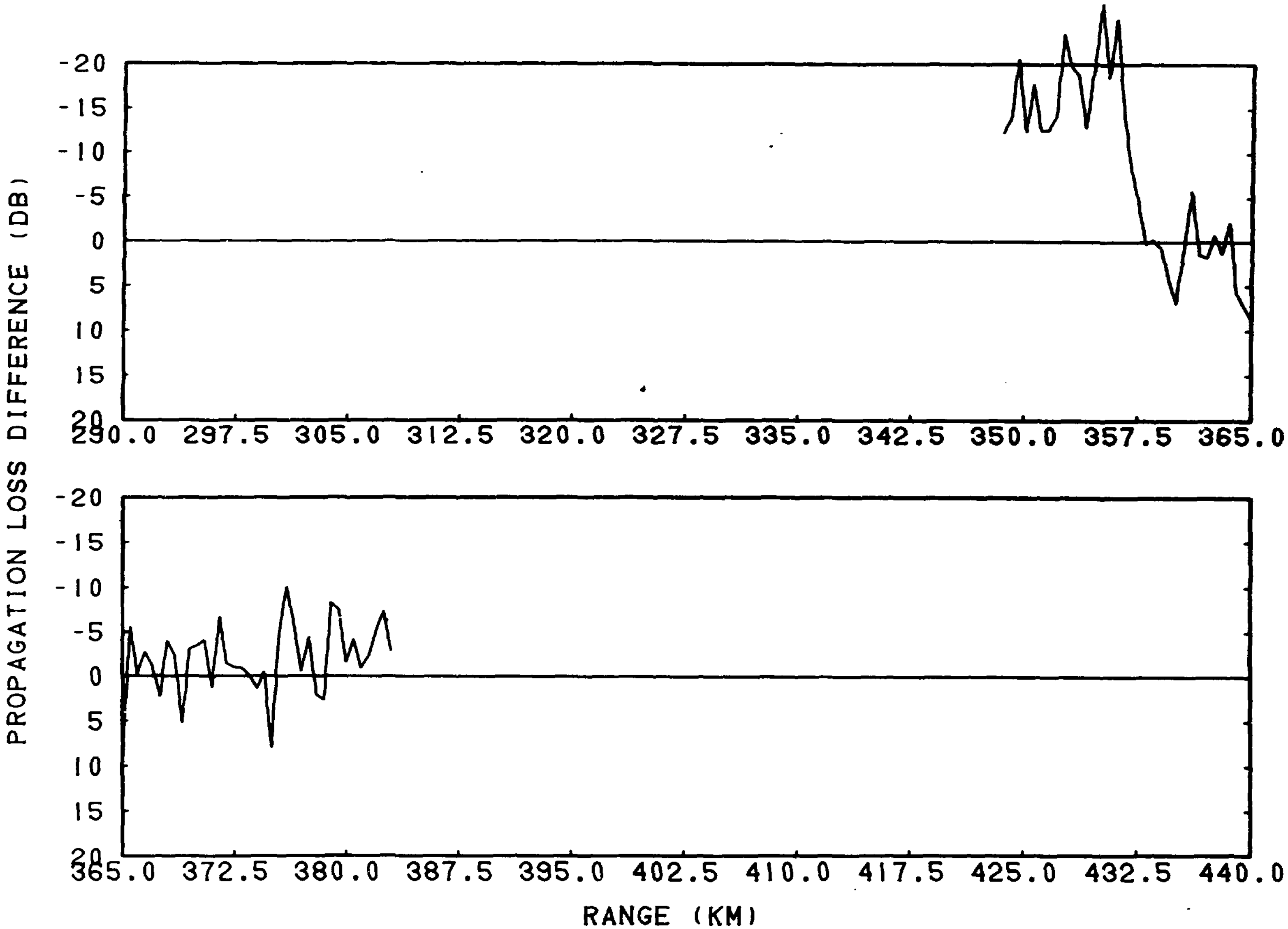
(C) Figure IIE-40. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 14D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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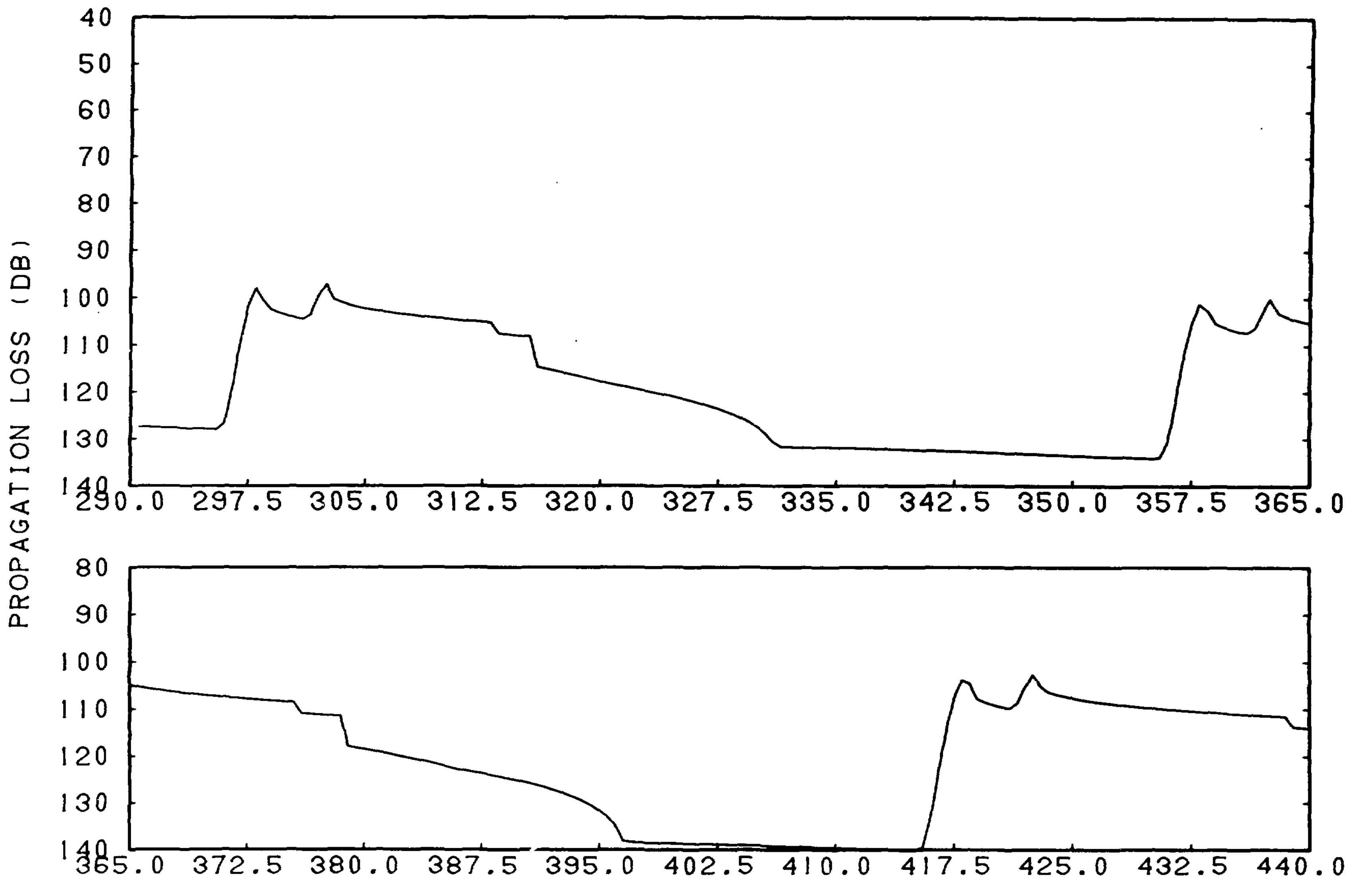
(C) Figure IIE-41. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 14D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters, Subtracted from LORAD Run 14D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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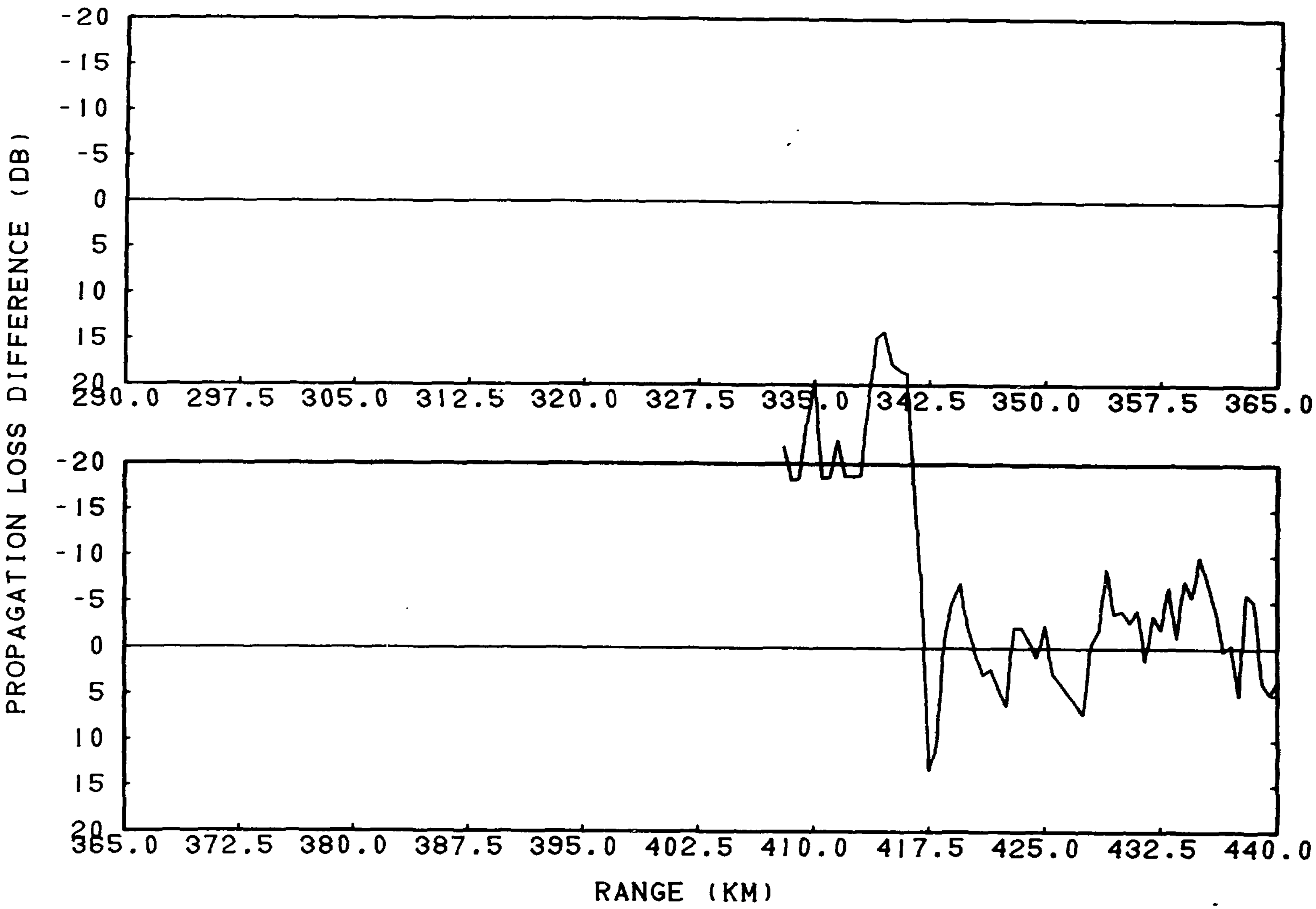
(C) Figure IIE-42. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 16D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters



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(C) Figure IIE-43. Generic FACT Incoherent, Bottom Loss = FNOC Type 5, Run 16D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters, Subtracted from LORAD Run 16D, Frequency = 0.53 Kilohertz, Source Depth = 15 Meters, Receiver Depth = 305 Meters

Appendix IIF. Accuracy Assessment of FACT PL9D Compared to JOAST Experiment Data IIF-1

JOAST III (U)

Environment (U)

(C) The JOAST III environments used for FACT model evaluation test cases are stations 1, 2, 3, and 5. The sound speed profile graphs and tables for these stations are given in Figures IIF1-4. The station 1 profile has a nearly isovelocity (slightly negative gradient) layer overlying a sound channel with axis at 137 meters. Bottom depth is 2816 m and a positive depth excess of approximately 700 m is found. The sound speed profile for station 2 has a negative gradient layer to 18.3 m above a sound channel with an axis depth of 61 m. The critical depth (i.e., depth at which the surface sound speed is again encountered) is 1530 m and the bottom depth is 2725 m. The positive depth excess is therefore 1195 m. The sound speed profile for station 3 is similar to that for station 2. A slightly negative gradient surface layer to 18.3 m overlays a sound channel with axis at 70 m. The critical depth is at 1998 m and the bottom depth is at 3471 m, yielding a positive depth excess of 1473 m. The sound speed profile for station 5 is unique among the JOAST stations in that a positive gradient surface duct is found which extends to 44.2 m above a slightly negative gradient layer to a depth of 149.6 m, at which point a deep sound channel begins. The deep sound channel axis is at 442.3 m, the critical depth at about 1900 m and the bottom at 2743.2 m, giving a positive excess of 843 m.

(C) The bottom loss vs grazing angle curves for stations 1 and 2 are given in Figure IIF-5, for station 3 in Figure IIF-6, and for station 5 in Figure IIF-7. Bottom loss vs. grazing angle is tabulated for stations 1 and 2 in Table IIF-1, for station 3 in Table IIF-2, and for station 5 in Table IIF-3. The curves for stations 1 and 2 are FNOC type 2 having 3.5 dB loss at 0 degrees, 4.8 dB loss at 15 degrees, and 9 dB loss at normal incidence. For station 3 the FNOC type 3 bottom applies and is characterized by 5.8 dB loss at zero degrees, 7.6 dB loss at 15 degrees and 11.5 dB loss at 90 degrees (a maximum loss of 11.6 dB is found from 76 to 80 degrees). For station 5, an FNOC type 8 bottom is found. At 0 degrees the loss is 13.1 dB, at 15 degrees the loss is 26.7 dB, and at normal incidence the loss is 25.0 dB. This curve has two local maxima: 28.2 dB at 24 degrees and 26.5 dB at 80 degrees.

Test Cases (U)

(C) Fourteen test cases were chosen from the Joint Oceanographic Acoustic and System Test (JOAST) III results. For all cases but one the receivers were the uppermost (60 feet), middle (260 feet), and lowest (535 feet) hydrophones of a vertical array. The JOAST III experiment covered all basins of the Mediterranean Sea (see Martin, 1981, for details). In all cases the source was the AN/SQS-26 sonar transmitting pulsed signals at a frequency of 3700 Hz. The source was at a depth of 20 feet. Data were obtained by towing the vertical array through the first convergence zone while the source remained in fixed position. Ranges were precisely determined by radio link. A list of the test cases is as follows:

Case	Station	Run	Receiver Depth (ft)	Figure
I	1	43	60	IIF8a-i
II	1	43	260	IIF9a-i
III	1	43	535	IIF10a-i
IV	2	63	60	IIF11a-i
V	2	63	260	IIF12a-i
VI	2	63	535	IIF13a-i
VII	3	43	60	IIF14a-i
VIII	3	43	260	IIF15a-i
IX	3	43	535	IIF16a-i
X	3	103	60	IIF17a-i
XI	3	93	535	IIF18a-i
XII	5	43	60	IIF19a-i
XIII	5	43	260	IIF20a-i
XIV	5	43	1000	IIF21a-i

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Accuracy Assessment Results (U)

(C) The accuracy assessment procedures were followed as outlined in section 1.1 and described in detail in Volume I of this series, with the exception that in the Difference Technique, means and standard deviations were not calculated. These calculations were omitted since a slight error in convergence zone range leads to a large value for the standard deviation which can be easily misinterpreted as an error in convergence zone shape.

(U) The following figures were produced for each case: (a) JOAST experimental data, (b) FACT PL9D output using the coherent option, (c) the coherent result smoothed by application of a 2 km window running average, (d) the smoothed coherent result subtracted from the JOAST data, (e) FACT PL9D output using the semi-coherent phase addition option, (f) the semi-coherent result smoothed by application of a 2 km window running average, (g) the smoothed semi-coherent result subtracted from JOAST data, (h) FACT PL9D using the incoherent phase option, and (i) the incoherent result subtracted from JOAST data. The figures for the first case are numbered IIF-8a through IIF-8i, for the second case IIF-9a through IIF-9i, etc.

(U) The results of the figure of merit versus detection range analysis are given in tables IIF-4 through IIF-17.

(U) The results for each case are summarized below. Unless otherwise stated, results pertain to the semi-coherent phase addition option.

(C) Case I (Station 1, Run 43, Source/Receiver Depth = 20 ft/60 ft)

(C) The convergence zone start ranges are in basic agreement between JOAST and FACT PL9D. The zone width given by FACT is approximately 2 km greater than the JOAST measured value. Bottom bounce energy corrupts the CZ onset of JOAST results for FOM $\geq$ 95 dB. Bottom bounce energy corrupts the CZ end of FACT for FOM $\geq$ 105 dB. JOAST and FACT have peak values of 80 dB in the CZ.

(C) Case II (Station 1, Run 43, Source/Receiver Depth = 20 ft/260 ft)

(C) The JOAST convergence zone onset shows probable bottom bounce effects for FOM $\geq$ 100 dB. The FACT CZ is affected by bottom bounce energy for FOM > 100 dB. FACT's CZ is multilobed except for the incoherent phase option. The JOAST convergence zone is approximately 1.5 km narrower than the FACT PL9D predicted CZ. The convergence zone peaks are found at 84 dB for both JOAST and FACT results.

(C) Case III (Station 1, Run 43, Source/Receiver Depth = 20 ft/535 ft)

(C) The JOAST data shows contamination of the convergence zone start by bottom bounce energy for FOM > 100 dB. The JOAST zone width is narrower than that given by the FACT PL9D model by 1 to 3 kyd, with the disparity increasing with increasing figure of merit. The JOAST data appears to consist of two lobes; the FACT result consists, of three lobes for the semi-coherent phase option, numerous spikes and lobes for coherent phase, and a single-lobed CZ for incoherent phase addition. The end of the FACT CZ is found at greater range than extrapolation would indicate due to bottom bounce energy for FOM $\geq$ 105 dB.

Both JOAST and FACT agree on peak CZ values of 87 dB.

(C) Case IV (Station 2, Run 63, Source/Receiver Depth = 20 ft/60 ft)

(C) The convergence zone envelopes for JOAST and FACT PL9D are essentially identical; however, details differ significantly. JOAST shows fluctuations of 5-10 dB; FACT coherent has a multi-lobed structure with variability of 15-20 dB; FACT semi-coherent basically consists of three lobes with 15-20 dB variations; and FACT incoherent has almost no variability. The onset of the FACT CZ is 1 km shorter than that for JOAST as is the end. Therefore, a translation of FACT to greater range by 1 km would bring JOAST data and FACT results into almost perfect agreement. In this context we note that both JOAST and FACT have peak levels of 76 dB. The JOAST CZ start is bottom bounce dominated for FOM $\geq$ 97 dB whereas FACT's CZ start is bottom bounce dominated for FOM $\geq$ 92 dB.

(C) Case V (Station 2, Run 63, Source/Receiver Depth = 20 ft/260 ft)

(C) As in the previous case, CZ envelopes agree quite well between JOAST and FACT as do their peak levels of 82 dB. The FACT CZ begins 2 km shorter than does JOAST's CZ. There may be some indication of lobe structure in the JOAST data. FACT shows four lobes modulated by spikes for the coherent option, four lobes without spikes for the semicoherent option and no lobes when incoherence is selected. Bottom bounce affects the CZ results at zone start of FACT for FOM > 95 dB and of JOAST for FOM $\geq$ 100 dB.

(C) Case VI (Station 2, Run 63, Source/Receiver Depth = 20 ft/535 ft)

(C) Once again the convergence zone envelopes of the JOAST data and FACT output are almost identical. Lobe structure is evident in the JOAST data and very complicated structure is found for FACT coherent and semi-coherent. The FACT zone start is found to be 2 km less than JOAST and the end 1 km less. The effect of bottom bounce on the JOAST CZ is not evident in this case. FACT, however, shows the effect of bottom bounce on the zone start for FOM > 95 dB and on the zone end for FOM > 105 dB. Both JOAST and FACT have peak levels of 84 dB.

(C) Case VII (Station 3, Run 43, Source/Receiver Depth = 20 ft/60 ft)

(C) For values of FOM $\leq$ 90 dB, JOAST and FACT have similar envelopes and agree with regard to CZ start and end ranges. For FOM = 95 dB, start ranges are still in agreement but FACT exhibits an anomalous extension which the JOAST data does not show, the disparity being 6 km. FACT is bottom bounce dominated at the CZ start for FOM $\geq$ 100 dB; no bottom bounce is evident for JOAST to FOM = 115 dB. The peak values of JOAST and FACT are both 78 dB.

(C) Case VIII (Station 3, Run 43, Source/Receiver Depth = 20 ft/260 ft)

(C) The convergence zone envelopes for JOAST and FACT are similar at the zone start and through the zone (including the presence of two lobes) but differ greatly at the zone end - the JOAST data shows a steady falloff to past 130 dB whereas FACT shows an anomalous feature from 47 to 55 km which is due, at least in part, to bottom bounce energy. The extension of the FACT CZ due to the anomalous feature is evident in the inherent result. Peak values of 84 dB for FACT and 86 dB for JOAST are found.

(C) Case IX (Station 3, Run 43, Source/Receiver Depth = 20 ft/535 ft)

(C) The JOAST convergence zone consists of two primary lobes with peaks at 88 dB and a third lobe at 45 km with a peak value of 96 dB. Through the first two lobes, JOAST and FACT are almost identical. The third lobe is not, however, present in the FACT output but, rather, the same anomalous feature as in the

previous two cases between 47.5 and 52 km. The minimum loss peak for FACT is 85 dB.

(C) Case X (Station 3, Run 103, Source/Receiver Depth = 20 ft/60 ft)

(C) The convergence zone envelopes of JOAST and FACT are quite similar for FOM ≤ 90 dB but past 45 km FACT's falloff is in disagreement with JOAST, the FACT CZ being anomalously extended (similar to cases VII - IX). The peak values of JOAST and FACT are 78 dB. The zone starts agree to within 0.5 km for FOM ≤ 95 dB with the FACT CZ having shorter onset range than JOAST; for FOM > 95 dB, the zone starts agree to within 1 km with FACT once again found a shorter range than JOAST. FACT incoherent has an extended CZ due to the anomalous feature observed in the coherent and semi-coherent results.

(C) Case XI (Station 3, Run 103, Source/Receiver Depth = 20 ft/535 ft)

(C) The convergence zone envelopes for JOAST and FACT data are essentially the same for ranges less than 47 km and figures of merit ≤ 100 dB. Beyond 47 km, FACT exhibits additional energy not indicated by JOAST. This energy substantially lengthens the convergence zone in the incoherent phase result. The minimum loss peak values are 84 dB for JOAST and 85 dB for FACT.

(C) Case XII (Station 5, Run 43, Source/Receiver Depth = 20 ft/60 ft)

(C) The JOAST CZ has a typical shape for this data set but has an unusually high minimum loss peak value of 86 dB. This high value may be caused by the presence of a surface duct with both source and receiver in the duct. In the FACT result, the effect of the surface duct is obvious and dominates the propagation loss. The convergence zone is evident from its modulation of the surface duct pattern between 42 and 43 km, which agrees with the JOAST range. The FACT CZ level is 79 dB, which is in keeping with previous results at 60 feet when no duct was evident. The FACT surface duct module clearly failed in this case to even qualitatively predict the JOAST measurement results.

(C) Case XIII (Station 5, Run 43, Source/Receiver Depth = 20 ft/260 ft)

As in previous cases FACT shows an anomalous extension to the convergence zone which is unsupported by the JOAST experimental data. The JOAST and FACT convergence zone envelopes show little resemblence to each other in shape or level. The onset of FACT is at 3 km shorter range than that of JOAST, and FACT is double-lobed before the anomalous extension whereas JOAST does not show multi-lobed structure. This is a cross-layer case for FACT. The minimum loss peak levels are 82 dB for FACT and 88 dB for JOAST.

(C) Case XIV (Station 5, Run 43, Source/Receiver Depth = 20 ft/260 ft)

(C) This is a cross-layer case as was case XIII and the only case where the receiver is at 1000 feet. Unfortunately, the onset of the zone is not included in the JOAST data. Once again, as with the previous two cases, JOAST and FACT strongly disagree. FACT has a minimum loss peak of 81 dB and JOAST has a peak value of 97 dB. FACT has four lobes visible although it is not clear that all belong to the convergence zone.

General Conclusions (U)

(C) Except for the last three cases which involved a surface duct, the JOAST experimental data and FACT model results were in excellent agreement with respect to convergence zone start and shape of the zone with the serious exception that for stations 2 and 3 (cases IV - IX) the FACT result shows an anomalous and substantial broadening of the zone at its end. FACT CZ results are generally marked by bottom bounce energy for figure of merit values greater than 105-110 dB whereas JOAST results rarely show this

effect. Results for the final three cases are ambiguous in that the JOAST data has lower CZ levels than previous stations (i.e., 1, 2, and 3) but shows a reasonably shaped CZ when compared to results for other stations. FACT results for station 5 show anomalous zone extension to long ranges, and in case XII, where both source and receiver were in the duct, the convergence zone was masked by the surface duct contribution.

References (U)

1. Martin, R. L. et al. (1982). The Acoustic Model Evaluation Committee (AMEC) Reports. Volume IA. Summary of Range Independent Environmental Acoustic Propagation Loss Data Sets (U). Naval Ocean Research and Development Activity Report No. 34. CONFIDENTIAL

(C) Table IIF-1. Bottom Loss (dB) vs. Grazing Angle (degrees) for JOAST III Stations 1 and 2. FNOC Type 2. Frequency = 3.7 kHz.

Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL
0	3.49	13	4.56	26	6.03	39	7.40	52	8.37	65	8.85	78	8.96
1	3.54	14	4.66	27	6.15	40	7.49	53	8.43	66	8.87	79	8.96
2	3.60	15	4.77	28	6.26	41	7.58	54	8.48	67	8.89	80	8.96
3	3.67	16	4.88	29	6.37	42	7.67	55	8.53	68	8.90	81	8.96
4	3.74	17	5.00	30	6.48	43	7.75	56	8.57	69	8.91	82	8.96
5	3.81	18	5.11	31	6.59	44	7.83	57	8.61	70	8.92	83	8.96
6	3.89	19	5.22	32	6.70	45	7.91	58	8.65	71	8.93	84	8.96
7	3.98	20	5.34	33	6.81	46	7.98	59	8.69	72	8.94	85	8.96
8	4.07	21	5.45	34	6.91	47	8.06	60	8.72	73	8.95	86	8.97
9	4.16	22	5.57	35	7.01	48	8.13	61	8.75	74	8.95	87	8.97
10	4.25	23	5.69	36	7.11	49	8.19	62	8.78	75	8.95	88	8.98
11	4.35	24	5.80	37	7.21	50	8.26	63	8.81	76	8.96	89	8.99
12	4.45	25	5.92	38	7.31	51	8.32	64	8.83	77	8.96	90	9.00

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(C) Table IIF-2. Bottom Loss (dB) vs. Grazing Angle (degrees) for JOAST III Station 3. FNOC Type 3. Frequency = 3.7 kHz.

Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL
0	5.79	13	7.39	26	8.83	39	10.03	52	10.92	65	11.45	78	11.62
1	5.91	14	7.50	27	8.94	40	10.11	53	10.97	66	11.48	79	11.62
2	6.04	15	7.62	28	9.04	41	10.19	54	11.02	67	11.50	80	11.62
3	6.16	16	7.74	29	9.14	42	10.27	55	11.07	68	11.52	81	11.61
4	6.29	17	7.85	30	9.23	43	10.34	56	11.12	69	11.54	82	11.60
5	6.41	18	7.97	31	9.33	44	10.41	57	11.17	70	11.56	83	11.59
6	6.54	19	8.08	32	9.42	45	10.49	58	11.21	71	11.57	84	11.58
7	6.66	20	8.19	33	9.52	46	10.55	59	11.25	72	11.59	85	11.57
8	6.78	21	8.30	34	9.61	47	10.62	60	11.29	73	11.60	86	11.56
9	6.90	22	8.41	35	9.70	48	10.68	61	11.33	74	11.61	87	11.54
10	7.03	23	8.52	36	9.78	49	10.75	62	11.36	75	11.61	88	11.52
11	7.15	24	8.63	37	9.87	50	10.81	63	11.39	76	11.62	89	11.50
12	7.27	25	8.73	38	9.95	51	10.86	64	11.42	77	11.62	90	11.48

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(C) Table IIF-3. Bottom Loss (dB) vs. Grazing Angle (degrees) for JOAST III Station 5. FNOC Type 8. Frequency = 3.7 kHz.

Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL
0	13.07	13	25.83	26	28.12	39	26.52	52	25.10	65	25.39	78	26.42
1	14.61	14	26.28	27	28.07	40	26.37	53	25.06	66	25.48	79	26.44
2	16.05	15	26.67	28	28.00	41	26.22	54	25.03	67	25.56	80	26.45
3	17.38	16	27.01	29	27.91	42	26.08	55	25.01	68	25.65	81	26.44
4	18.61	17	27.30	30	27.80	43	25.94	56	25.00	69	25.74	82	26.40
5	19.74	18	27.54	31	27.69	44	25.81	57	25.01	70	25.84	83	26.32
6	20.78	19	27.73	32	27.56	45	25.69	58	25.02	71	25.93	84	26.26
7	21.73	20	27.89	33	27.43	46	25.58	59	25.05	72	26.02	85	26.14
8	22.60	21	28.00	34	27.28	47	25.47	60	25.08	73	26.10	86	25.99
9	23.39	22	28.09	35	27.13	48	25.38	61	25.13	74	26.18	87	25.81
10	24.11	23	28.14	36	26.98	49	25.29	62	25.18	75	26.26	88	25.59
11	24.75	24	28.16	37	26.83	50	25.22	63	25.25	76	26.32	39	25.32
12	25.32	25	28.15	38	26.68	51	25.15	64	25.32	77	26.38	90	25.01

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(C) Table IIF-4. Convergence Zone (CZ) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-Coherent, and Incoherent Phase Addition, Case I (Station 1, Run 43, Source Depth = 20 ft, Receiver Depth = 60 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
80	JOAST	39.0	40.5	
	FACT Coherent	38.5	39.5	
	FACT Semi-coherent	38.5	38.5	
	FACT Incoherent	38.5	38.5	
85	JOAST	39.0	42.0	
	FACT Coherent	38.5	44.5	
	FACT Semi-coherent	38.5	44.5	
	FACT Incoherent	38.5	42.0	
90	JOAST	38.0	43.5	
	FACT Coherent	38.5	45.0	CZ is multi-lobed for FOM ≤ 90 dB
	FACT Semi-coherent	38.0	45.0	CZ is double-lobed for FOM ≤ 91 dB
	FACT Incoherent	38.5	45.0	
95	JOAST	36.5	44.0	CZ start includes bottom bounce effect for FOM ≥ 95 dB
	FACT Coherent	38.0	45.0	
	FACT Semi-coherent	38.0	45.0	
	FACT Incoherent	38.0	45.0	
100	JOAST	36.0	44.5	
	FACT Coherent	38.0	45.0	
	FACT Semi-coherent	38.0	45.0	
	FACT Incoherent	----	45.5	
105	JOAST	35.0	46.0	
	FACT Coherent	37.0	45.5	CZ includes some bottom bounce energy
	FACT Semi-coherent	37.0	46.0	CZ includes some bottom bounce energy
	FACT Incoherent	----	45.5	
110	JOAST	35.0	----	
	FACT Coherent	37.0	----	
	FACT Semi-coherent	38.0	47.5	CZ includes some bottom bounce energy
	FACT Incoherent	----	----	

1. Detection ranges accurate to ±0.25 km

2. Coherent results are unsmoothed

(C) Table IIF-5. Convergence Zone (CZ) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent and Incoherent Phase Addition. Case II

(Station 1, Run 43, Source Depth = 20 ft, Receiver Depth = 260 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
85	JOAST	39.0	40.0	
	FACT Coherent	38.0	38.0	Single spike
	FACT Semi-coherent	38.0	38.0	Single spike
	FACT Incoherent	38.5	38.5	
90	JOAST	38.5	41.0	
	FACT Coherent	38.0	44.0	
	FACT Semi-coherent	38.0	44.0	
	FACT Incoherent	38.0	42.0	
95	JOAST	38.0	43.5	
	FACT Coherent	38.0	44.5	CZ is multi-lobed for FOM < 95 dB
	FACT Semi-coherent	38.0	45.0	CZ is multi-lobed for FOM < 98 dB
	FACT Incoherent	38.0	45.0	
100	JOAST	35.5	43.5	CZ start corrupted by bottom bounce
	FACT Coherent	37.5	44.5	
	FACT Semi-coherent	38.0	45.0	
	FACT Incoherent	37.5	45.0	
105	JOAST	35.5	44.5	
	FACT Coherent	37.5	46.0	Slight broadening due to bottom bounce
	FACT Semi-coherent	37.0	46.0	Slight broadening due to bottom bounce
	FACT Incoherent	----	45.5	
110	JOAST	35.0	45.0	
	FACT Coherent	36.5	47.0	Broadening of CZ due to bottom bounce
	FACT Semi-coherent	36.5	47.0	Broadening of CZ due to bottom bounce
	FACT Incoherent	----	----	
115	JOAST	35.0	----	
	FACT Coherent	36.5	47.5	Broadening of CZ due to bottom bounce
	FACT Semi-coherent	----	47.5	Broadening of CZ due to bottom bounce
	FACT Incoherent	----	----	

1. Detection ranges accurate to ±0.25 km

2. Coherent results are unsmoothed

(C) Table IIF-6. Convergence Zone (CZ) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent, and Incoherent Phase Addition. Case III.

(Station 1, Run 43, Source Depth = 20 ft, Receiver Depth = 535 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
85	JOAST	----	----	
	FACT Coherent	37.5	37.5	
	FACT Semi-coherent	37.5	37.5	
	FACT Incoherent	37.5	37.5	
90	JOAST	38.0	42.0	
	FACT Coherent	37.5	43.5	
	FACT Semi-coherent	37.5	44.0	
	FACT Incoherent	37.5	41.5	
95	JOAST	37.5	43.5	CZ double-lobed for FOM < 103 dB
	FACT Coherent	37.5	44.0	CZ multi-lobed for FOM < 105 dB
	FACT Semi-coherent	37.5	44.0	CZ multi-lobed for FOM < 103 dB
	FACT Incoherent	37.5	44.5	
100	JOAST	37.0	44.0	
	FACT Coherent	37.0	45.0	
	FACT Semi-coherent	37.0	45.0	
	FACT Incoherent	----	45.0	
105	JOAST	35.0	44.5	
	FACT Coherent	37.0	45.5	CZ end greater due to bottom bounce energy
	FACT Semi-coherent	37.0	45.5	CZ end greater due to bottom bounce energy
	FACT Incoherent	----	46.0	
110	JOAST	----	45.0	
	FACT Coherent	36.5	46.5	
	FACT Semi-coherent	36.5	47.0	
	FACT Incoherent	----	----	
115	JOAST	----	45.0	
	FACT Coherent	36.5	47.5	
	FACT Semi-coherent	----	47.5	
	FACT Incoherent	----	----	

1. Detection ranges accurate to ± 0.25 km
2. Coherent results are unsmoothed

(C) Table IIF-7. Convergence Zone (CZ) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent, and Incoherent Phase Addition. Case IV (Station 2, Run 63, Source Depth = 20 ft, Receiver Depth = 60 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
75	JOAST	36.0	36.0	
	FACT Coherent	----	----	
	FACT Semi-coherent	----	----	
	FACT Incoherent	----	----	
80	JOAST	35.0	36.0	
	FACT Coherent	34.0	37.0	
	FACT Semi-coherent	34.0	36.0	
	FACT Incoherent	34.0	36.0	
85	JOAST	35.0	38.5	
	FACT Coherent	33.5	38.5	
	FACT Semi-coherent	34.0	37.0	
	FACT Incoherent	34.0	37.0	
90	JOAST	35.0	41.0	
	FACT Coherent	33.5	42.5	
	FACT Semi-coherent	33.5	42.0	
	FACT Incoherent	33.5	40.0	
95	JOAST	34.5	43.5	
	FACT Coherent	33.5	42.5	
	FACT Semi-coherent	33.5	43.0	
	FACT Incoherent	33.5	43.0	
100	JOAST	32.5	44.0	Zone start possibly bottom bounce energy
	FACT Coherent	33.0	42.5	
	FACT Semi-coherent	----	43.0	
	FACT Incoherent	----	43.0	
105	JOAST	----	44.5	
	FACT Coherent	----	43.0	CZ multi-lobed for FOM ≤ 107 dB
	FACT Semi-coherent	----	43.0	CZ multi-lobed for FOM ≤ 103 dB
	FACT Incoherent	----	43.5	
110	JOAST	----	45.0	
	FACT Coherent	----	44.0	
	FACT Semi-coherent	----	44.0	
	FACT Incoherent	----	----	

1. Detection ranges accurate to ±0.25 km
2. Coherent results are unsmoothed

(C) Table IIF-8. Convergence Zone (CZ) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent, and Incoherent Phase Addition. Case V (Station 2, Run 63, Source Depth = 20 ft, Receiver Depth = 260 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
85	JOAST	35.0	36.5	
	FACT Coherent	34.0	36.0	
	FACT Semi-coherent	33.5	36.0	
	FACT Incoherent	33.0	36.0	
90	JOAST	35.0	38.5	
	FACT Coherent	33.0	41.5	
	FACT Semi-coherent	33.0	38.5	
	FACT Incoherent	33.0	37.5	
95	JOAST	34.5	43.0	
	FACT Coherent	33.0	42.0	
	FACT Semi-coherent	33.0	42.5	
	FACT Incoherent	33.0	43.0	
100	JOAST	32.0	44.0	
	FACT Coherent	32.0	43.0	
	FACT Semi-coherent	----	43.0	
	FACT Incoherent	----	43.0	
105	JOAST	32.0	44.0	
	FACT Coherent	----	43.0	CZ Multi-lobed for FOM $\leq$ 105 dB
	FACT Semi-coherent	----	43.0	CZ Multi-lobed for FOM $\leq$ 106 dB
	FACT Incoherent	----	43.0	
110	JOAST	----	45.5	
	FACT Coherent	----	43.0	
	FACT Semi-coherent	----	44.0	Slight bottom bounce effect at CZ end
	FACT Incoherent	----	----	
115	JOAST	----	45.5	
	FACT Coherent	----	44.5	
	FACT Semi-coherent	----	44.5	
	FACT Incoherent	----	----	

1. Detection ranges accurate to ±0.25 km
2. Coherent results are unsmoothed

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(C) Table IIF-9. Convergence Zone (CZ) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent, and Incoherent Phase Addition. Case VI

(Station 2, Run 63, Source Depth = 20 ft, Receiver Depth = 535 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
85	JOAST	37.0	37.0	
	FACT COHERENT	33.0	37.5	
	FACT Semi-coherent	33.0	35.0	
	FACT Incoherent	32.5	33.5	
90	JOAST	34.5	39.0	
	FACT Coherent	32.5	41.5	
	FACT Semi-coherent	32.5	38.0	
	FACT Incoherent	32.5	37.5	
95	JOAST	34.0	42.0	
	FACT Coherent	32.0	42.0	
	FACT Semi-coherent	32.0	42.0	
	FACT Incoherent	32.5	42.5	
100	JOAST	32.0	44.5	
	FACT Coherent	----	42.5	
	FACT Semi-coherent	----	42.5	
	FACT Incoherent	----	42.5	
105	JOAST	32.0	44.5	
	FACT Coherent	----	42.5	
	FACT Semi-coherent	----	43.0	CZ multi-lobed for FOM $<$ 106 dB
	FACT Incoherent	----	42.5	
110	JOAST	----	44.5	
	FACT Coherent	----	42.5	CZ multi-lobed for FOM $<$ 108 dB
	FACT Semi-coherent	----	44.0	CZ contaminated by bottom bounce energy
	FACT Incoherent	----	----	
115	JOAST	----	45.5	
	FACT Coherent	----	----	
	FACT Semi-coherent	----	44.5	CZ contaminated by bottom bounce energy
	FACT Incoherent	----	----	

1. Detection ranges accurate to ±0.25 km
2. Coherent results are unsmoothed

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(C) Table IIF-10. Convergence Zone (CZ) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent, and Incoherent Phase Addition. Case VII

(Station 3, Run 43, Source Depth = 20 ft, Receiver Depth = 60 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
80	JOAST	40.0	42.0	
	FACT Coherent	39.0	40.5	
	FACT Semi-coherent	39.0	40.5	
	FACT Incoherent	39.0	40.5	
85	JOAST	39.5	42.5	
	FACT Coherent	39.0	42.0	CZ double-lobed for FOM $\leq$ 85 dB
	FACT Semi-coherent	39.0	42.0	CZ double-lobed for FOM $\leq$ 85 dB
	FACT Incoherent	39.0	41.0	
90	JOAST	39.0	44.0	
	FACT Coherent	39.0	44.0	
	FACT Semi-coherent	39.0	44.0	
	FACT Incoherent	38.5	43.5	
95	JOAST	39.0	44.5	CZ multi-lobed for FOM $\leq$ 95 dB
	FACT Coherent	38.5	50.0	CZ anomaly for for FOM $\geq$ 95 dB re. CZ end
	FACT Semi-coherent	38.5	50.5	Also an anomalous peak at 50 km
	FACT Incoherent	38.5	50.0	
100	JOAST	39.0	44.5	
	FACT Coherent	37.0	52.0	
	FACT Semicoherent	36.5	52.0	CZ end is anomalous for FOM $\geq$ 90 dB
	FACT Incoherent	36.5	53.0	
105	JOAST	39.0	45.5	
	FACT Coherent	35.0	54.0	CZ contaminated by bottom bounce energy
	FACT Semi-coherent	35.0	54.0	CZ contaminated by bottom bounce energy
	FACT Incoherent	----	----	
110	JOAST	38.5	45.5	
	FACT Coherent	34.5	----	CZ start contaminated by bottom bounce energy
	FACT Semi-coherent	34.5	----	CZ start contaminated by bottom bounce energy
	FACT Incoherent	----	----	
115	JOAST	37.5	46.5	
	FACT Coherent	34.5	----	CZ start contaminated by bottom bounce energy
	FACT Semi-coherent	34.5	----	CZ start contaminated by bottom bounce energy
	FACT Incoherent	----	----	

1. Detection ranges accurate to ±0.25 km
2. Coherent results are unsmoothed

(C) Table IIF-11. Convergence Zone (CZ) Start and End Ranges as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent, and Incoherent Phase Addition. Case VIII

(Station 3, Run 43, Source Depth = 20 ft, Receiver Depth = 260 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
85	JOAST	----	----	
	FACT Coherent	39.0	39.0	
	FACT Semi-coherent	39.0	39.0	
	FACT Incoherent	39.0	41.0	
90	JOAST	38.5	42.5	
	FACT Coherent	38.5	41.0	
	FACT Semi-coherent	38.5	41.0	
	FACT Incoherent	39.0	41.0	
95	JOAST	38.5	43.0	
	FACT Coherent	38.0	45.0	Anomalous peaks from 47 to 50 km
	FACT Semi-coherent	38.5	44.0	Anomalous peaks from 49 to 50 km
	FACT Incoherent	38.5	43.0	CZ double-lobed for FOM $\leq$ 96 dB
100	JOAST	38.5	44.5	
	FACT Coherent	36.5	46.0	Anomalous peaks from 47 to 51 km
	FACT Semi-coherent	38.0	46.0	Anomalous peak from 48 to 51.5 km
	FACT Incoherent	36.0	52.0	
105	JOAST	37.0	45.0	CZ double-lobed for FOM $\leq$ 103 dB
	FACT Coherent	35.0	46.5	Bottom bounce contamination at CZ Start. Anomalous peaks from 47 to 52.5 km.
	FACT Semi-coherent	35.0	46.5	Bottom bounce contamination at CZ Start. Anomalous peak from 47 to 52.5 km.
	FACT Incoherent	----	52.0	
110	JOAST	37.0	45.0	
	FACT Coherent	----	----	Bottom bounce contamination
	FACT Semi-coherent	----	----	Bottom bounce contamination
	FACT Incoherent	----	----	
115	JOAST	----	46.0	
	FACT Coherent	----	----	Bottom bounce contamination
	FACT Semi-coherent	----	----	Bottom bounce contamination
	FACT Incoherent	----	----	

1. Detection ranges accurate to ±0.25 km
2. Coherent results are unsmoothed

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(C) Table IIF-12. Convergence Zone (CA) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent, and Incoherent Phase Addition. Case IX

(Station 3, Run 43, Source Depth = 20 ft, Receiver Depth = 535 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
85	JOAST	----	----	
	FACT Coherent	38.5	41.0	CZ is 2 spikes
	FACT Semi-coherent	38.5	41.0	CZ is 2 spikes
	FACT Incoherent	39.0	41.0	CZ is 2 spikes
90	JOAST	38.5	42.5	CZ is 2 spikes
	FACT Coherent	38.0	41.5	CZ is 2 spikes
	FACT Semi-coherent	38.0	41.5	CZ is 2 spikes
	FACT Incoherent	38.0	41.5	CZ is 2 spikes
95	JOAST	38.5	43.0	
	FACT Coherent	38.0	44.5	Anomalous peaks from 47.5 to 50 km
	FACT Semi-coherent	38.0	44.0	Anomalous peak from 48.5 to 50 km
	FACT Incoherent	38.0	43.5	
100	JOAST	38.0	45.0	
	FACT Coherent	38.0	45.5	CZ[2] contaminated by bottom bounce: end
	FACT Semi-coherent	38.0	45.5	Anomalous peak from 47.5 to 51 km
	FACT Incoherent	36.0	52.0	
105	JOAST	37.0	45.5	
	FACT Coherent	----	----	CZ contaminated by bottom bounce energy
	FACT Semi-coherent	----	----	CZ contaminated by bottom bounce energy
	FACT Incoherent	----	52.0	
110	JOAST	37.0	46.0	
	FACT Coherent	----	----	
	FACT Semi-coherent	----	----	
	FACT Incoherent	----	----	
115	JOAST	----	46.5	
	FACT Coherent	----	----	
	FACT Semi-coherent	----	----	
	FACT Incoherent	----	----	

1. Detection ranges accurate to ±0.25 km
2. Coherent results are unsmoothed

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(C) Table IIF-13. Convergence Zone (CZ) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent, and Incoherent Phase Addition. Case X

(Station 3, Run 103, Source Depth = 20 ft, Receiver Depth = 60 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
80	JOAST	39.0	41.0	
	FACT Coherent	39.0	41.0	
	FACT Semi-coherent	39.0	40.5	
	FACT Incoherent	39.0	40.5	
85	JOAST	39.0	42.0	
	FACT Coherent	39.0	42.0	Double-lobed CZ for FOM $\leq$ 85 dB
	FACT Semi-coherent	39.0	42.0	Double-lobed CZ for FOM $\leq$ 85 dB
	FACT Incoherent	39.0	41.0	
90	JOAST	39.0	42.5	
	FACT Coherent	39.0	44.0	CZ end appears anomalous
	FACT Semi-coherent	39.0	44.0	
	FACT Incoherent	38.5	44.0	
95	JOAST	39.0	47.5	
	FACT Coherent	38.5	50.0	CZ end appears anomalous
	FACT Semi-coherent	39.0	50.5	CZ end appears anomalous
	FACT Incoherent	38.5	50.0	
100	JOAST	38.0	48.5	
	FACT Coherent	37.0	52.0	CZ end appears anomalous
	FACT Semi-coherent	37.5	52.0	CZ end appears anomalous
	FACT Incoherent	36.5	52.5	
105	JOAST	38.0	49.0	
	FACT Coherent	36.5	54.0	
	FACT Semi-coherent	36.5	54.5	
	FACT Incoherent	36.5	----	
110	JOAST	37.0	49.5	
	FACT Coherent	36.0	----	
	FACT Semi-coherent	36.0	----	
	FACT Incoherent	36.5		

1. Detection ranges accurate to ±0.25 km
2. Coherent results are unsmoothed

(C) Table IIF-14. Convergence Zone (CZ) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent, and Incoherent Phase Addition. Case XI (Station 2, Run 63, Source Depth = 20 ft, Receiver Depth = 535 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
85	JOAST	38.0	38.0	
	FACT Coherent	38.5	41.0	CZ consists of 2 peaks
	FACT Semi-coherent	38.5	41.0	CZ consists of 2 peaks
	FACT Incoherent	38.5	41.0	CZ consists of 2 peaks
90	JOAST	37.5	42.0	
	FACT Coherent	38.0	41.5	Double-lobed CZ
	FACT Semi-coherent	38.5	41.5	Double-lobed CZ
	FACT Incoherent	38.0	41.5	Double-lobed CZ
95	JOAST	37.5	43.0	
	FACT Coherent	38.0	44.5	Anomalous spikes from 48 to 50 km
	FACT Semi-coherent	38.0	44.5	Anomalous peak from 48.5 to 50 km
	FACT Incoherent	38.0	43.0	
100	JOAST	37.5	45.5	
	FACT Coherent	38.0	45.5	Anomalous spikes from 47.5 to 50.5 km. Double-lobed CZ for FOM ⩽ 101 dB.
	FACT Semi-coherent	38.0	45.5	Anomalous peak from 47.5 to 51 km. Double-lobed CZ for FOM ⩽ 97 dB.
	FACT Incoherent	37.5	52.0	Double-lobed CZ for FOM ⩾ 97 dB
105	JOAST	37.0	48.5	
	FACT Coherent	36.0	46.0	Anomalous spikes from 46.5 to 52 km
	FACT Semi-coherent	36.0	46.0	Anomalous peak from 46.5 to 52 km
	FACT Incoherent	36.0	52.0	
110	JOAST	----	49.0	
	FACT Coherent	36.0	----	
	FACT Semi-coherent	36.0	----	
	FACT Incoherent	36.0	----	
115	JOAST	----	----	
	FACT Coherent	36.0	----	
	FACT Semi-coherent	36.0	----	
	FACT Incoherent	----	----	

1. Detection ranges accurate to ±0.25 km
2. Coherent results are unsmoothed

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(C) Table IIF-15. Convergence Zone (CZ) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent, and Incoherent Phase Addition. Case XII

(Station 5, Run 43, Source Depth = 20 ft, Receiver Depth = 60 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
80	JOAST	----	----	
	FACT Coherent	41.5	43.0	CZ barely modulates erroneous surface duct contribution
	FACT Semi-coherent	41.5	43.0	CZ barely modulates erroneous surface duct contribution
	FACT Incoherent	41.5	42.0	CZ barely modulates erroneous surface duct contribution
85	JOAST	----	----	CZ barely modulates erroneous surface duct contribution
	FACT Coherent	----	----	
	FACT Semi-coherent	----	----	
	FACT Incoherent	----	----	
90	JOAST	41.5	43.0	
	FACT Coherent	----	----	Surface duct contribution masks CZ for FOM > 85 dB
	FACT Semi-coherent	----	----	
	FACT Incoherent	----	----	
95	JOAST	41.5	44.5	
	FACT Coherent	----	----	
	FACT Semi-coherent	----	----	
	FACT Incoherent	----	----	
100	JOAST	41.0	45.5	
	FACT Coherent	----	----	
	FACT Semi-coherent	----	----	
	FACT Incoherent	----	----	
105	JOAST	41.0	49.0	
	FACT Coherent	----	----	
	FACT Semi-coherent	----	----	
	FACT Incoherent	----	----	
110	JOAST	39.0	49.0	
	FACT Coherent	----	----	
	FACT Semi-coherent	----	----	
	FACT Incoherent	----	----	

1. Detection ranges accurate to ±0.25 km
2. Coherent results are unsmoothed

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(C) Table IIF-16. Convergence Zone (CZ) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent, and Incoherent Phase Addition. Case XIII

(Station 5, Run 43, Source Depth = 20 ft, Receiver Depth = 260 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
85	JOAST	----	----	
	FACT Coherent	38.0	41.5	CZ consists of two spikes
	FACT Semi-coherent	38.0	41.5	CZ consists of two spikes
	FACT Incoherent	39.0	41.0	CZ consists of two spikes
90	JOAST	41.0	42.0	
	FACT Coherent	38.0	42.5	Double-lobed CZ for FOM $\leq$ 92 dB
	FACT Semi-coherent	38.0	42.5	Double-lobed CZ for FOM $\leq$ 90 dB
	FACT Incoherent	38.0	44.5	Double-lobed CZ for FOM $\leq$ 88 dB
95	JOAST	40.0	43.5	
	FACT Coherent	38.0	43.0	Anomalous energy from 43 to 51 km
	FACT Semi-coherent	38.0	51.0	
	FACT Incoherent	38.0	51.0	
100	JOAST	40.0	46.0	
	FACT Coherent	----	----	CZ masked by erroneous surface duct contribution for FOM $\geq$ 95 dB
	FACT Semi-coherent	----	51.0	
	FACT Incoherent	----	51.0	
105	JOAST	39.5	48.0	
	FACT Coherent	----	----	
	FACT Semi-coherent	----	----	
	FACT Incoherent	----	----	
110	JOAST	39.0	49.0	
	FACT Coherent	----	----	
	FACT Semi-coherent	----	----	
	FACT Incoherent	----	----	
115	JOAST	39.0	49.0	
	FACT Coherent	----	----	
	FACT Semi-coherent	----	----	
	FACT Incoherent	----	----	

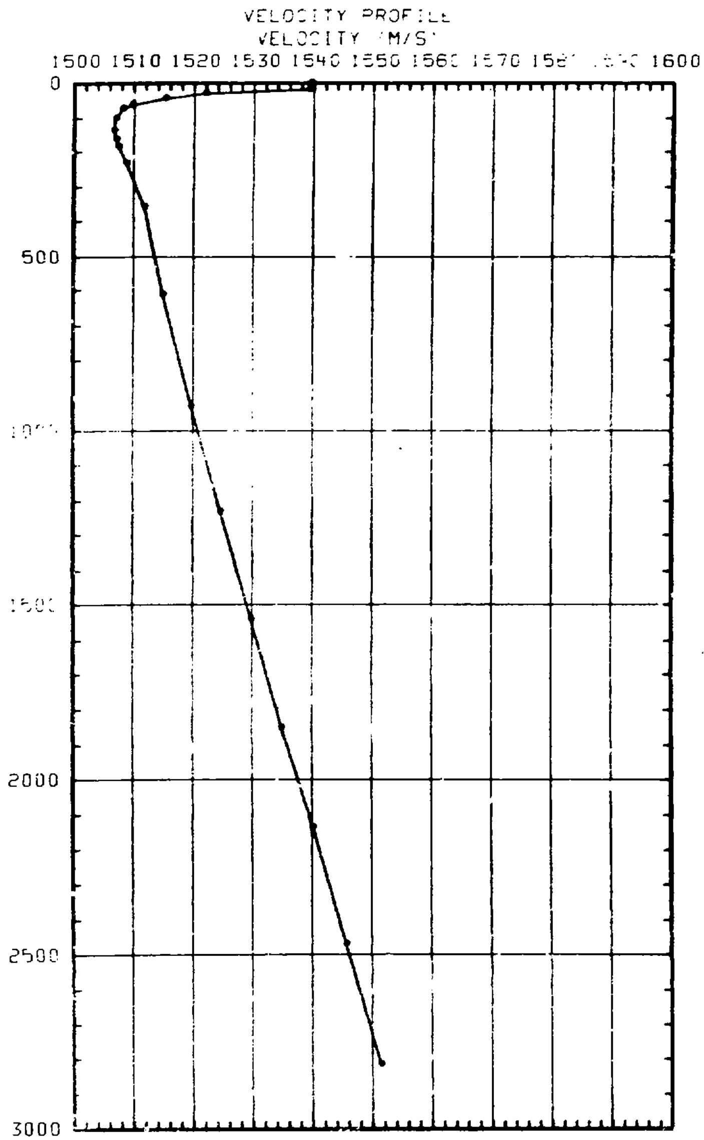
1. Detection ranges accurate to ±0.25 km
2. Coherent results are unsmoothed

(C) Table IIF-17. Convergence Zone (CZ) Start and End Ranges[1] as a Function of Figure of Merit (FOM) for JOAST III Experimental Data and FACT PL9D Predictions with Coherent[2], Semi-coherent, and Incoherent Phase Addition. Case XIV

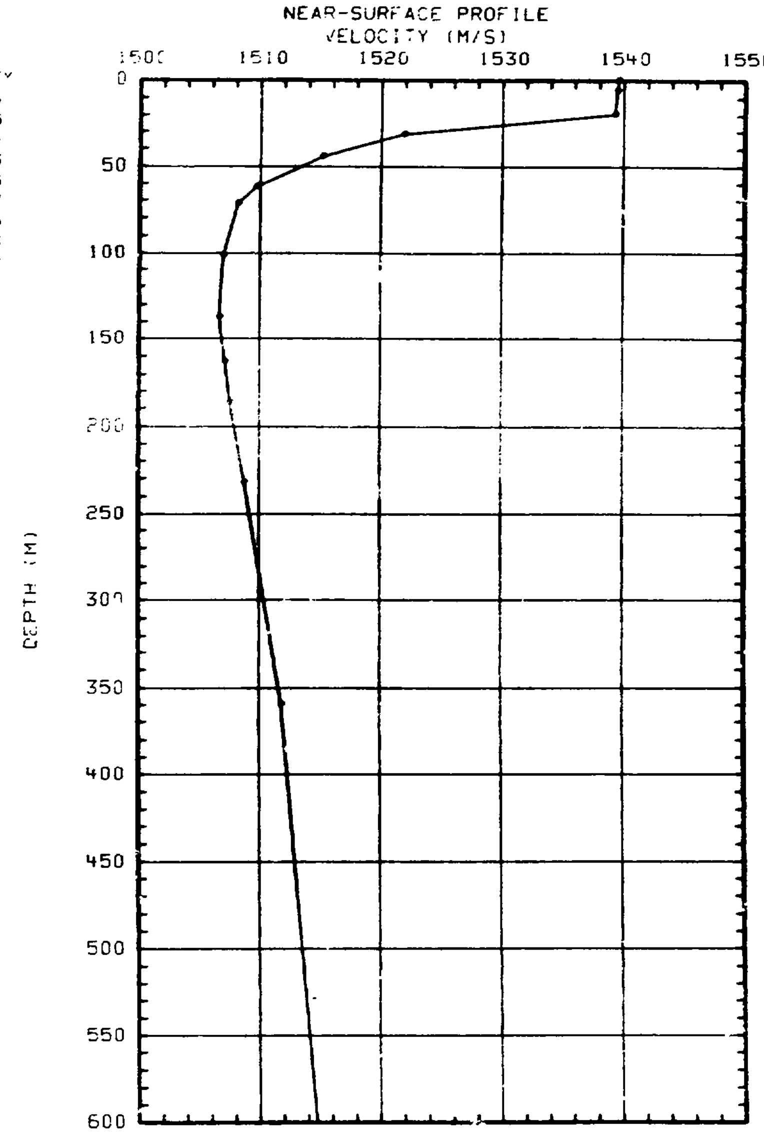
(Station 5, Run 43, Source Depth = 20 ft, Receiver Depth = 1000 ft, Frequency = 3.7 kHz)

FOM (dB)	Data Set	CZ Start Range (km)	CZ End Range (km)	Remarks
85	JOAST	----	----	
	FACT Coherent	38.5	39.0	
	FACT Semi-coherent	38.5	39.0	
	FACT Incoherent	38.5	38.5	
90	JOAST	----	----	
	FACT Coherent	38.5	43.5	CZ consists of 2 spikes
	FACT Semi-coherent	38.5	43.5	CZ consists of 2 spikes
	FACT Incoherent	38.0	43.5	CZ consists of 2 spikes
95	JOAST	----	----	
	FACT Coherent	38.0	48.5	CZ consists of 3 peaks
	FACT Semi-coherent	38.0	48.5	CZ consists of 3 peaks
	FACT Incoherent	38.0	48.5	
100	JOAST	----	42.5	
	FACT Coherent	38.0	49.0	Plus additional spike from 53.5 to 54.0 km
	FACT Semi-coherent	38.0	49.0	Plus additional spike from 53.5 to 54.0 km
	FACT Incoherent	38.0	49.0	Plus additional spike from 53.5 to 54.0 km
105	JOAST	----	45.5	
	FACT Coherent	38.0	49.0	Plus additional coverage from 51 to 54 km
	FACT Semi-coherent	38.0	49.0	Plus additional coverage from 51 to 54 km
	FACT Incoherent	38.0	54.0	
110	JOAST	----	47.0	
	FACT Coherent	----	54.0	CZ start masked by surface duct contribution
	FACT Semi-coherent	----	54.5	CZ start masked by surface duct contribution
	FACT Incoherent	----	----	
115	JOAST	----	49.5	
	FACT Coherent	----	----	CZ masked by surface duct contribution
	FACT Semi-coherent	----	----	CZ masked by surface duct contribution
	FACT Incoherent	----	----	

1. Detection ranges accurate to ±0.25 km
2. Coherent results are unsmoothed



DEPTH	VELOCITY
0.0	1539.54
6.1	1539.45
19.5	1539.24
31.7	1521.86
44.5	1515.16
61.9	1509.67
71.9	1508.15
101.5	1506.93
137.2	1506.62
163.1	1507.10
186.5	1507.54
232.2	1508.76
359.7	1511.81
513.2	1514.86
934.2	1519.73
1229.3	1524.61
1542.9	1529.79
1853.9	1534.97
2137.6	1540.15
2471.3	1545.64
2816.3	1551.43



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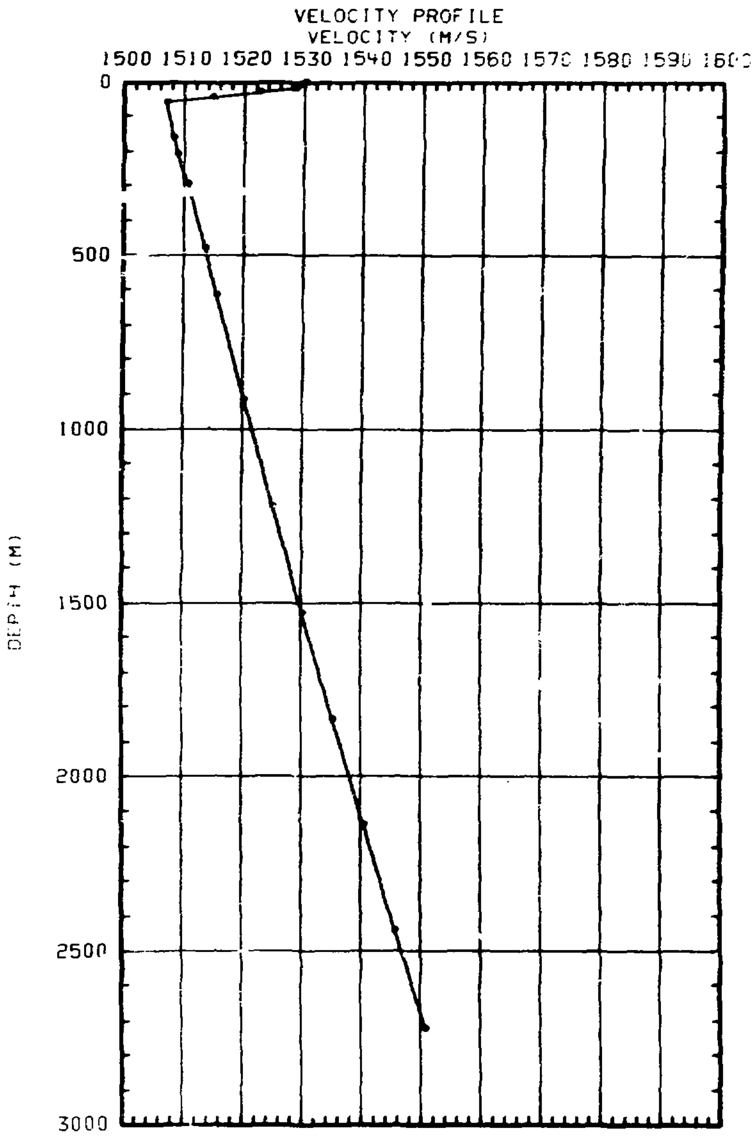
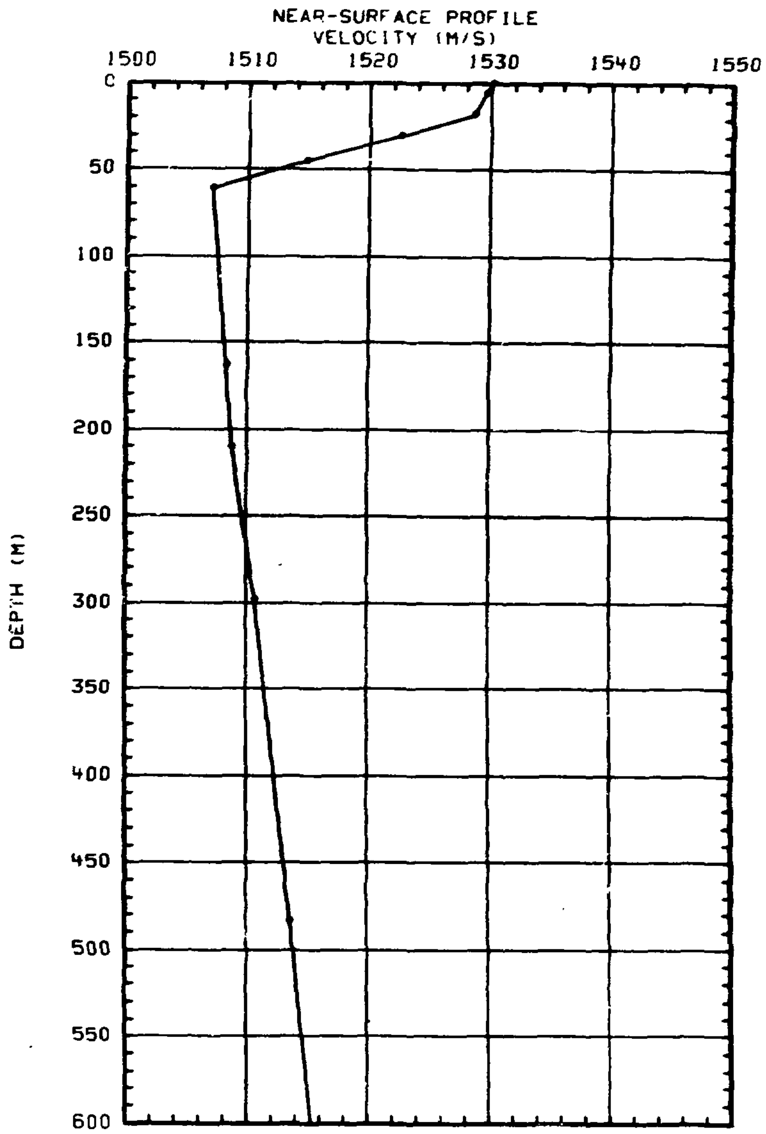
(U) Figure IIF-1. JOAST Station 1 Sound Speed Profile



DEPTH	VELOCITY
0.0	1530.10
6.1	1529.60
18.3	1528.60
30.5	1522.50
45.7	1514.80
61.0	1507.00
163.1	1508.20
210.6	1508.75
298.1	1510.70
484.0	1513.60
618.7	1515.60
920.2	1520.30
1225.9	1525.20
1530.4	1530.10
1838.2	1535.30
2141.5	1540.50
2445.4	1545.70
2724.9	1550.80



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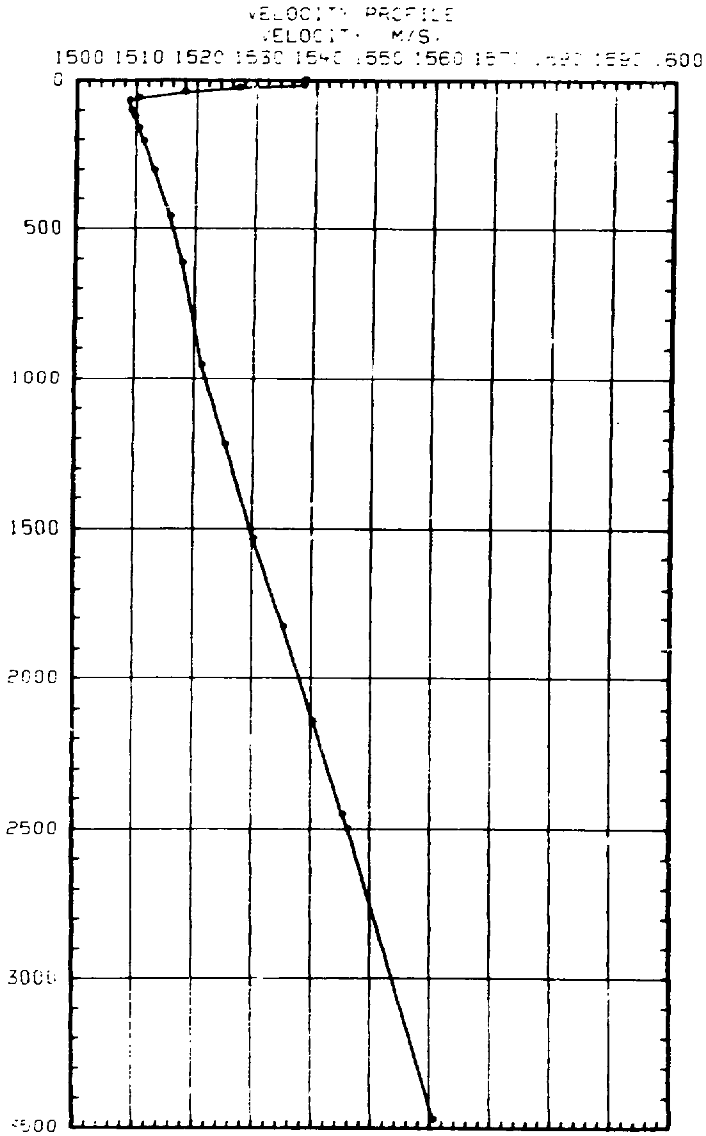
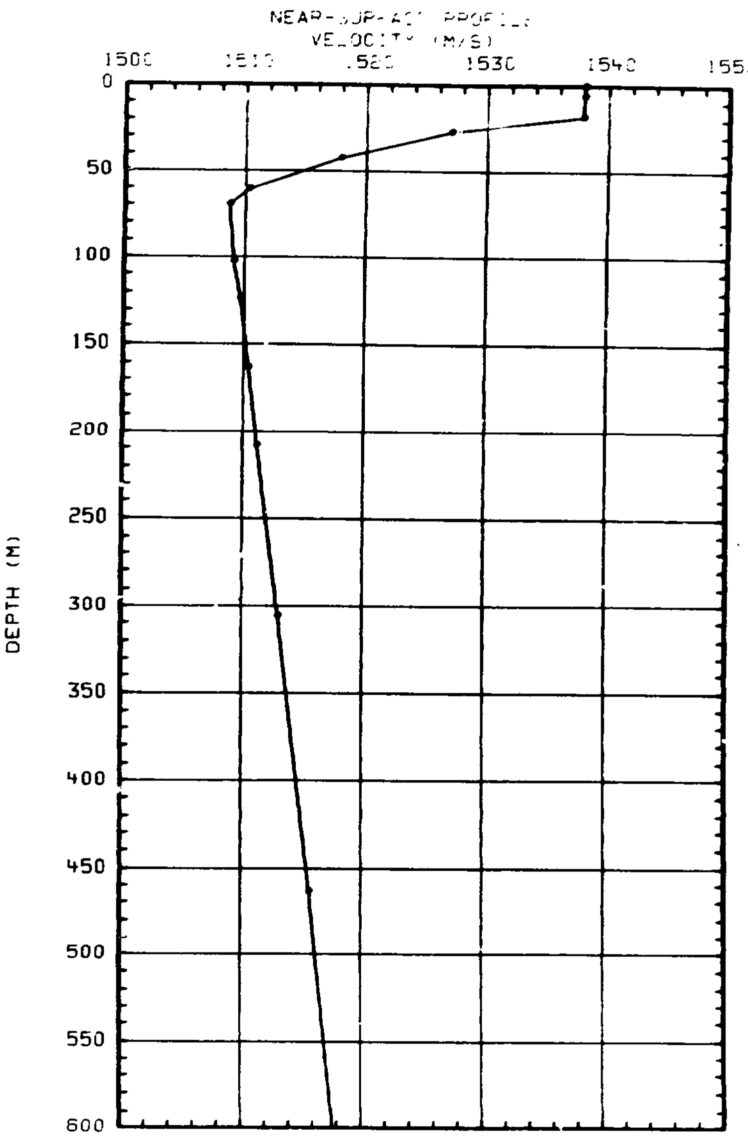
(U) Figure IIF-2. JOAST Station 2 Sound Speed Profile



DEPTH	VELOCITY
0.0	1538.00
6.1	1537.97
18.3	1537.90
27.4	1527.00
42.7	1517.90
61.0	1510.30
70.1	1508.70
103.0	1509.10
123.4	1509.70
163.1	1510.40
208.8	1511.20
306.3	1513.00
463.9	1515.70
617.5	1517.90
955.5	1521.20
1224.7	1525.40
1534.1	1530.10
1833.7	1535.30
2143.3	1540.40
2450.6	1545.30
2500.F	1546.30
3471.1	1560.60



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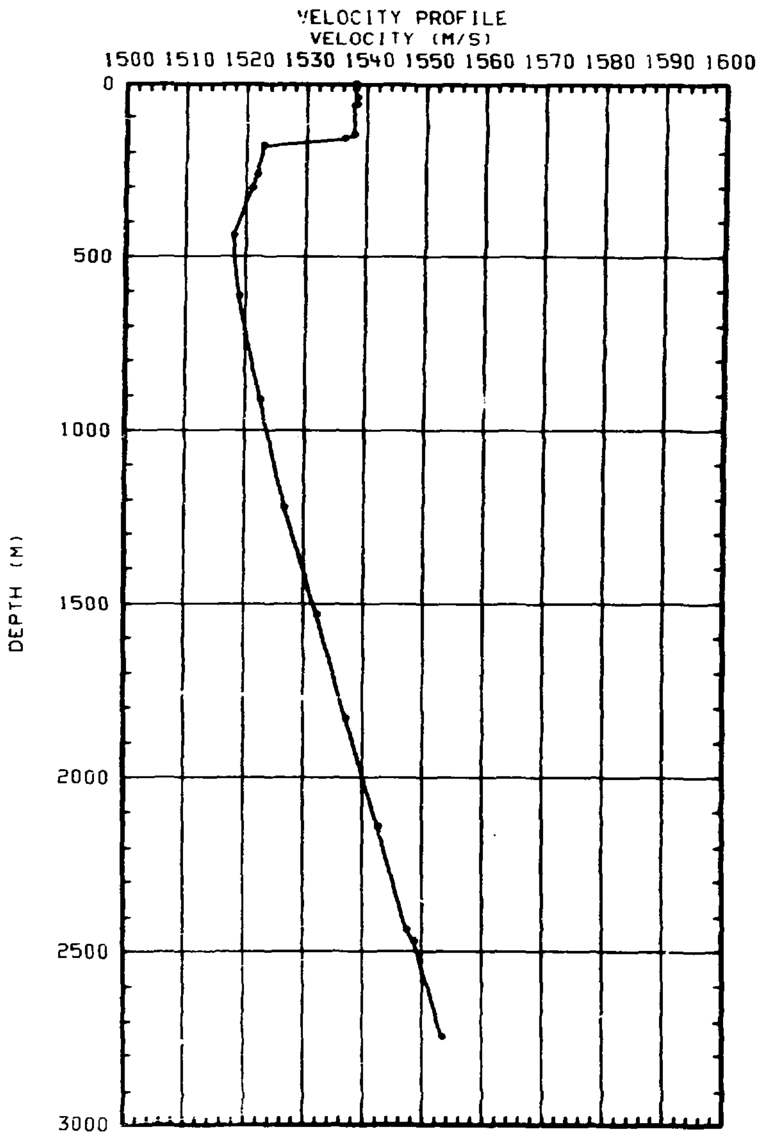
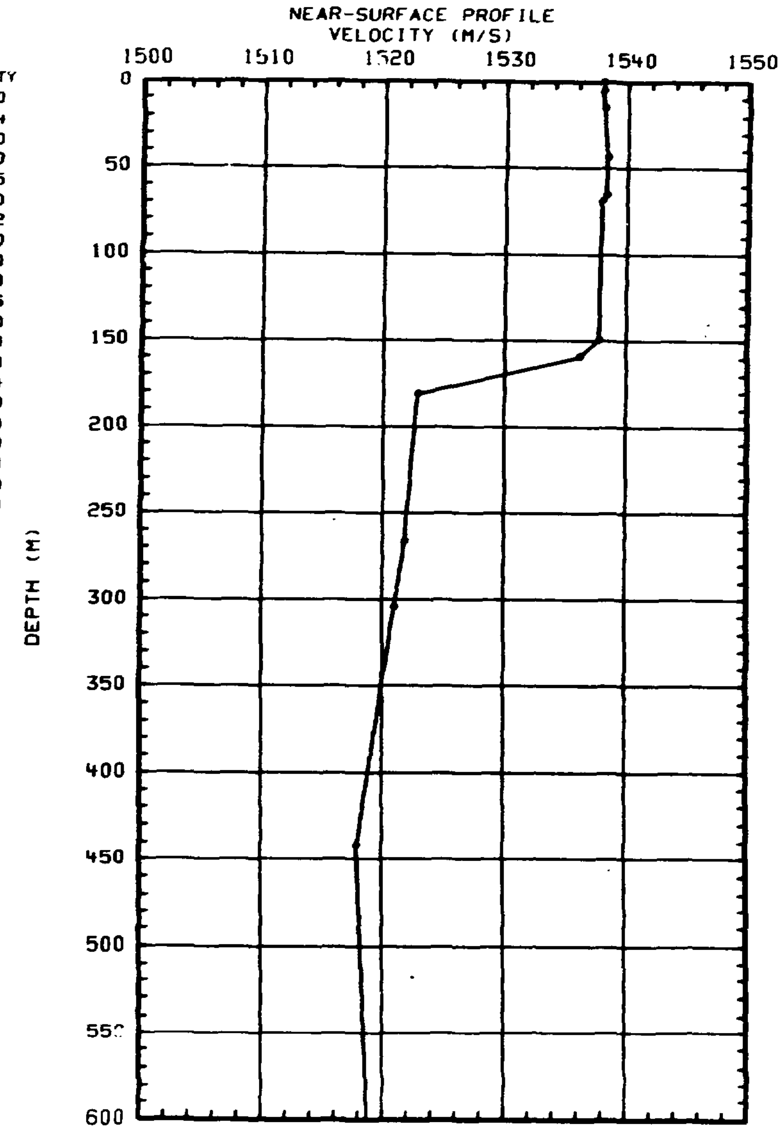
(U) Figure IIF-3. JOAST Station 3 Sound Speed Profile



DEPTH	VELOCITY
0.0	1537.90
6.1	1537.94
15.5	1538.00
44.2	1538.30
65.5	1538.25
68.9	1537.90
149.6	1537.72
159.4	1536.20
181.3	1522.80
267.0	1521.80
304.8	1520.96
442.3	1517.90
616 0	1518.80
914.7	1522.50
1225.0	1526.74
1534.1	1532.20
1832.8	1537.10
2144.3	1542.60
2439.9	1547.40
2475.3	1548.70
2743.2	1553.30



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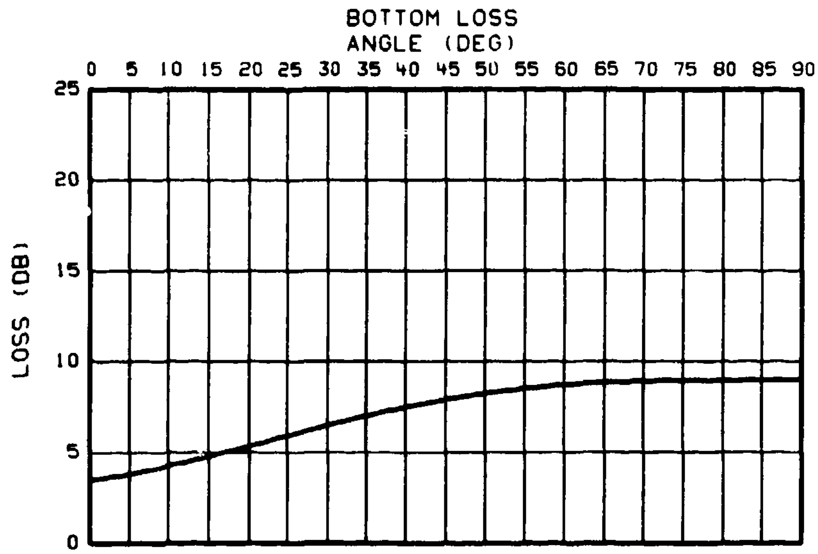
(U) Figure IIF-4. JOAST Station 5 Sound Speed Profile



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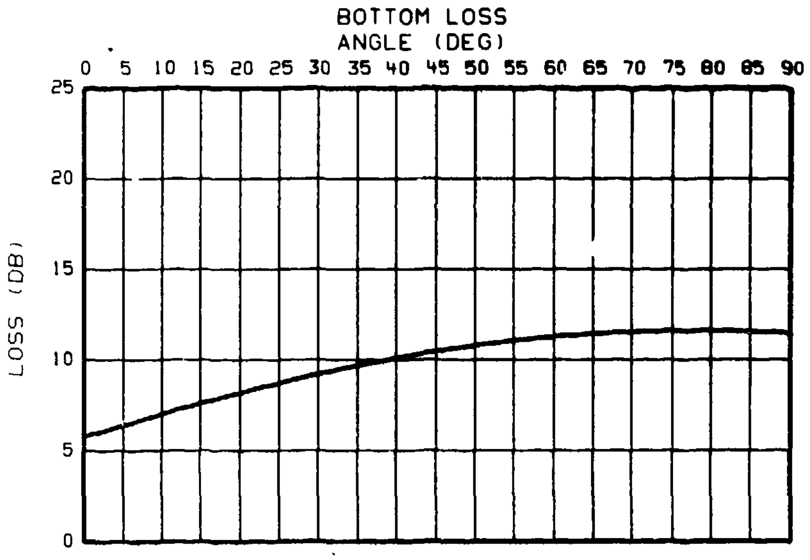
(C) Figure IIF-5. Bottom Loss Versus Grazing Angle for JOAST Stations 1 and 2, FNOC Type 2, Frequency = 3.7 Kilohertz



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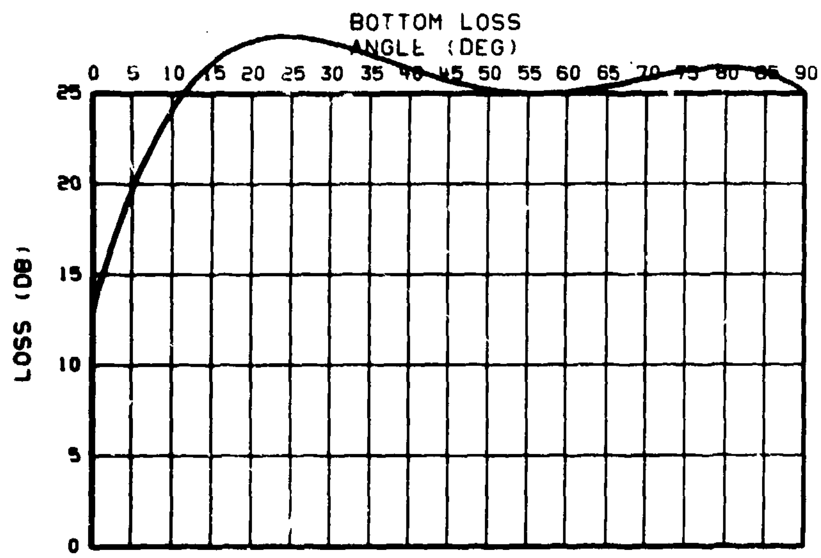
(C) Figure IIF-6. Bottom Loss Versus Grazing Angle for JOAST Station 3, FNOC Type 3, Frequency = 3700 Hertz



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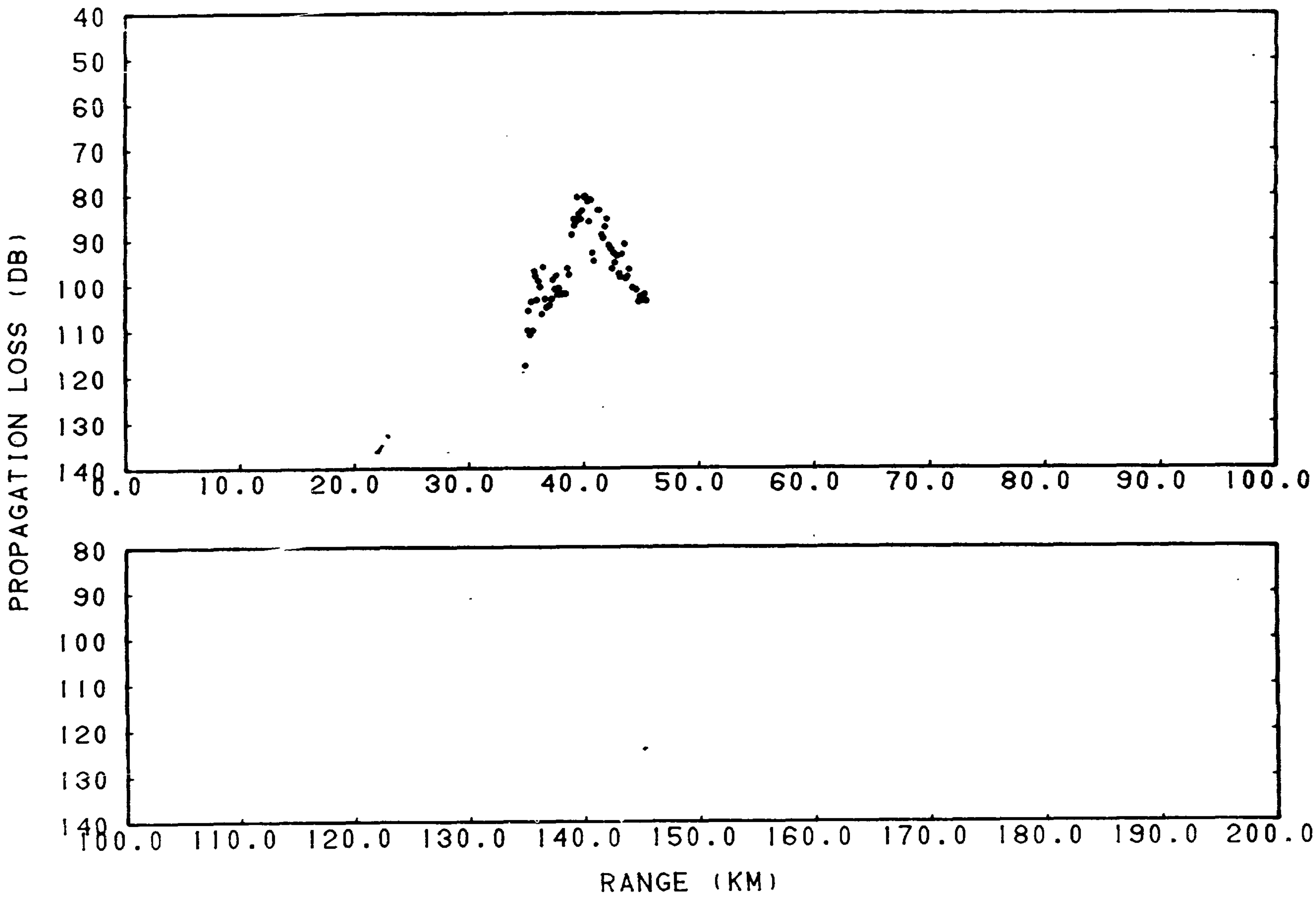
(C) Figure IIF-7. Bottom Loss Versus Grazing Angle for JOAST Station 5, FNOC Type 8, Frequency = 3700 Hertz



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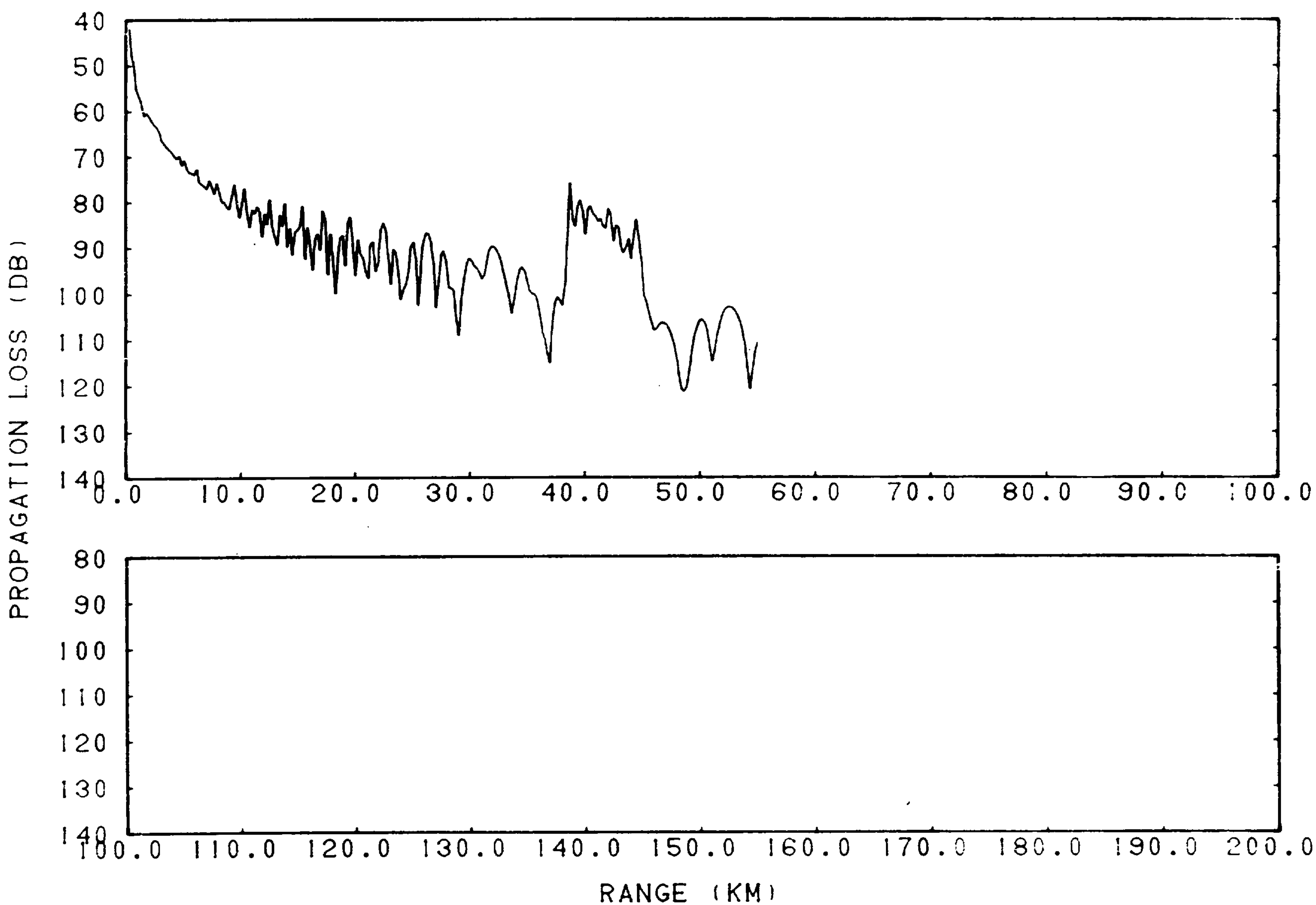
(C) Figure IIF-8a. Station 1 Run 43, Source Depth = 2C Feet, Receiver Depth = 60 Feet



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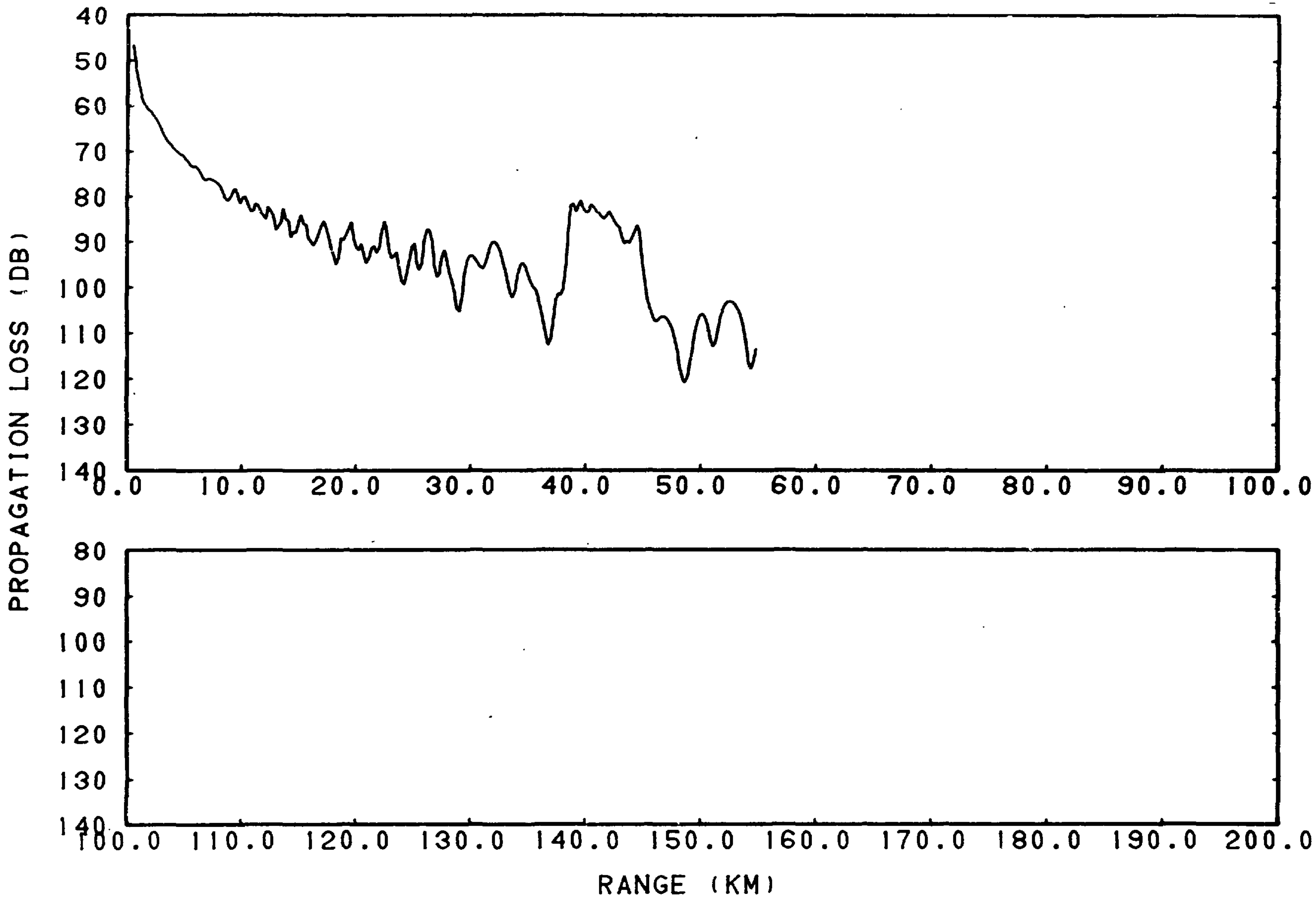
(C) Figure IIF-8b. FACT Coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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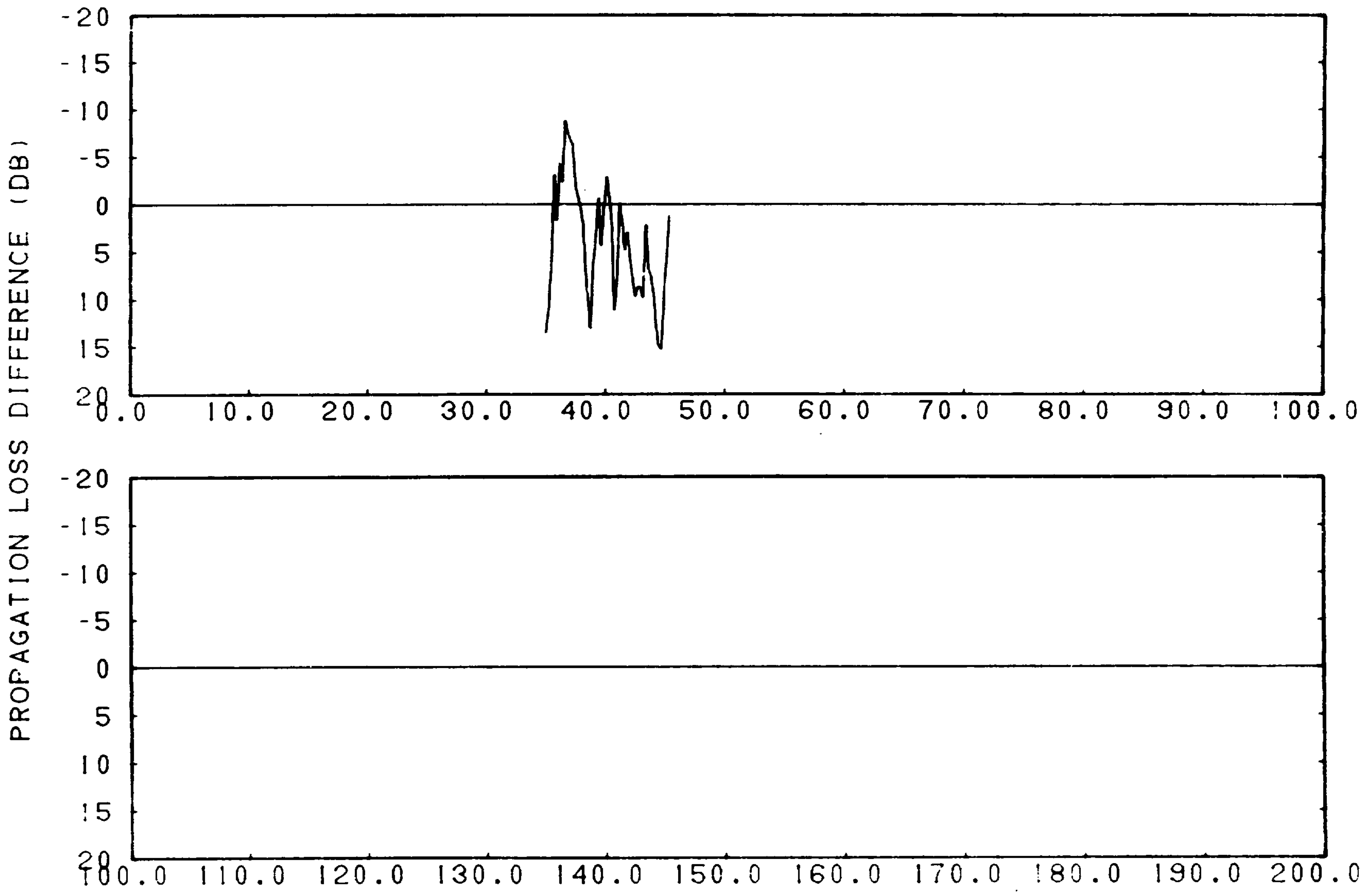
(C) Figure IIF-8c. FACT Coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



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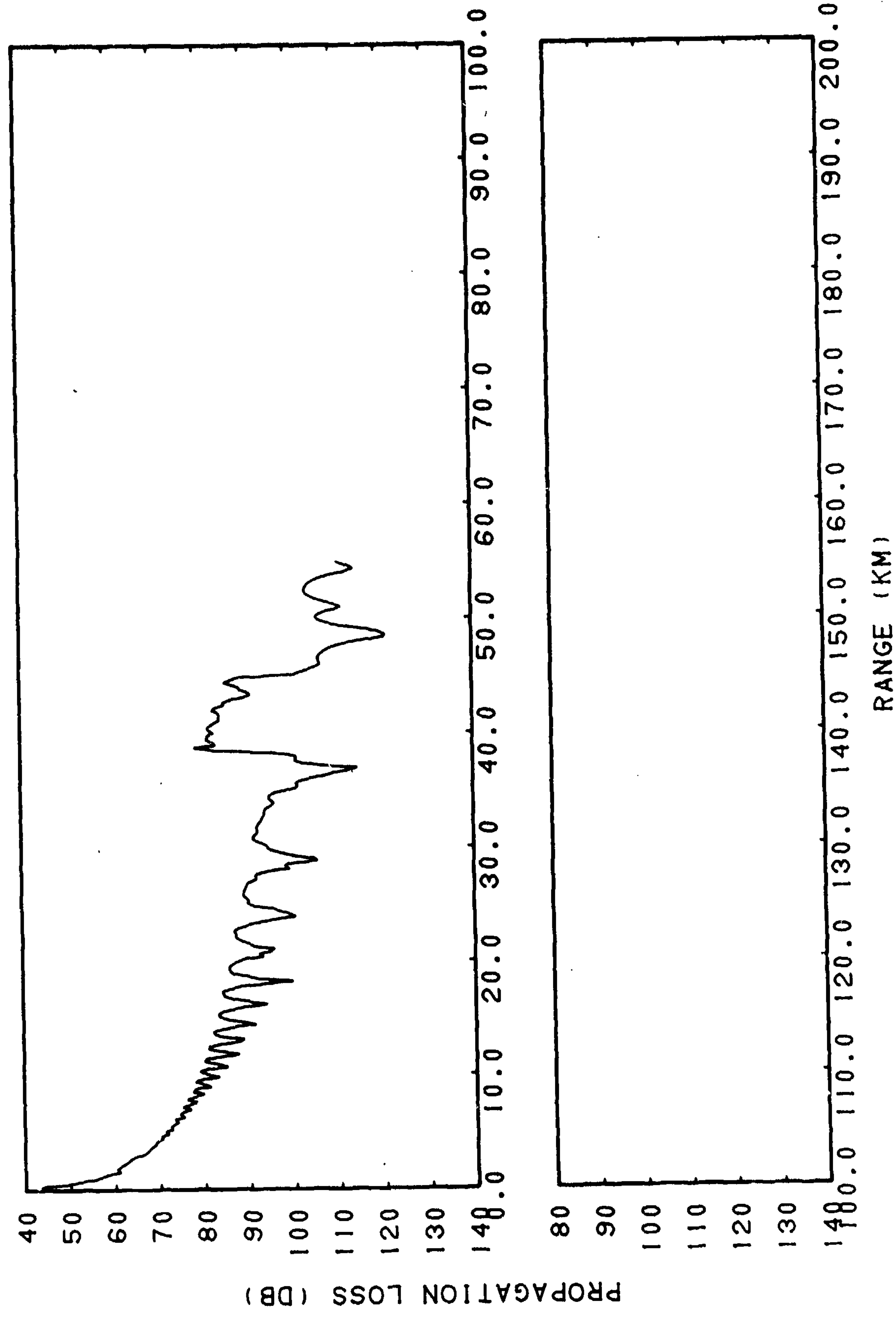
(C) Figure IIF-8d. Smoothed FACT Coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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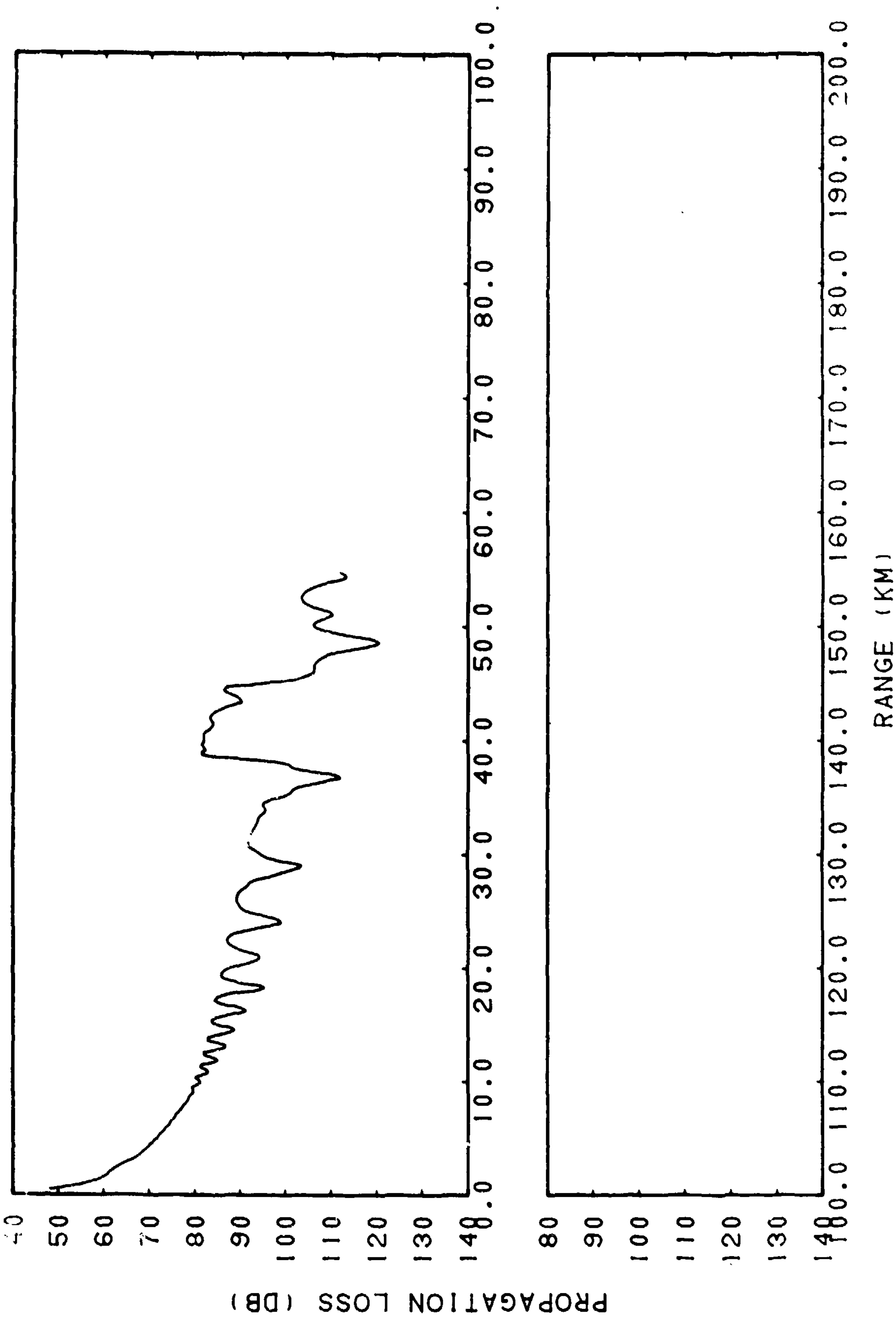
(C) Figure IIF-8e. FACT Semi-coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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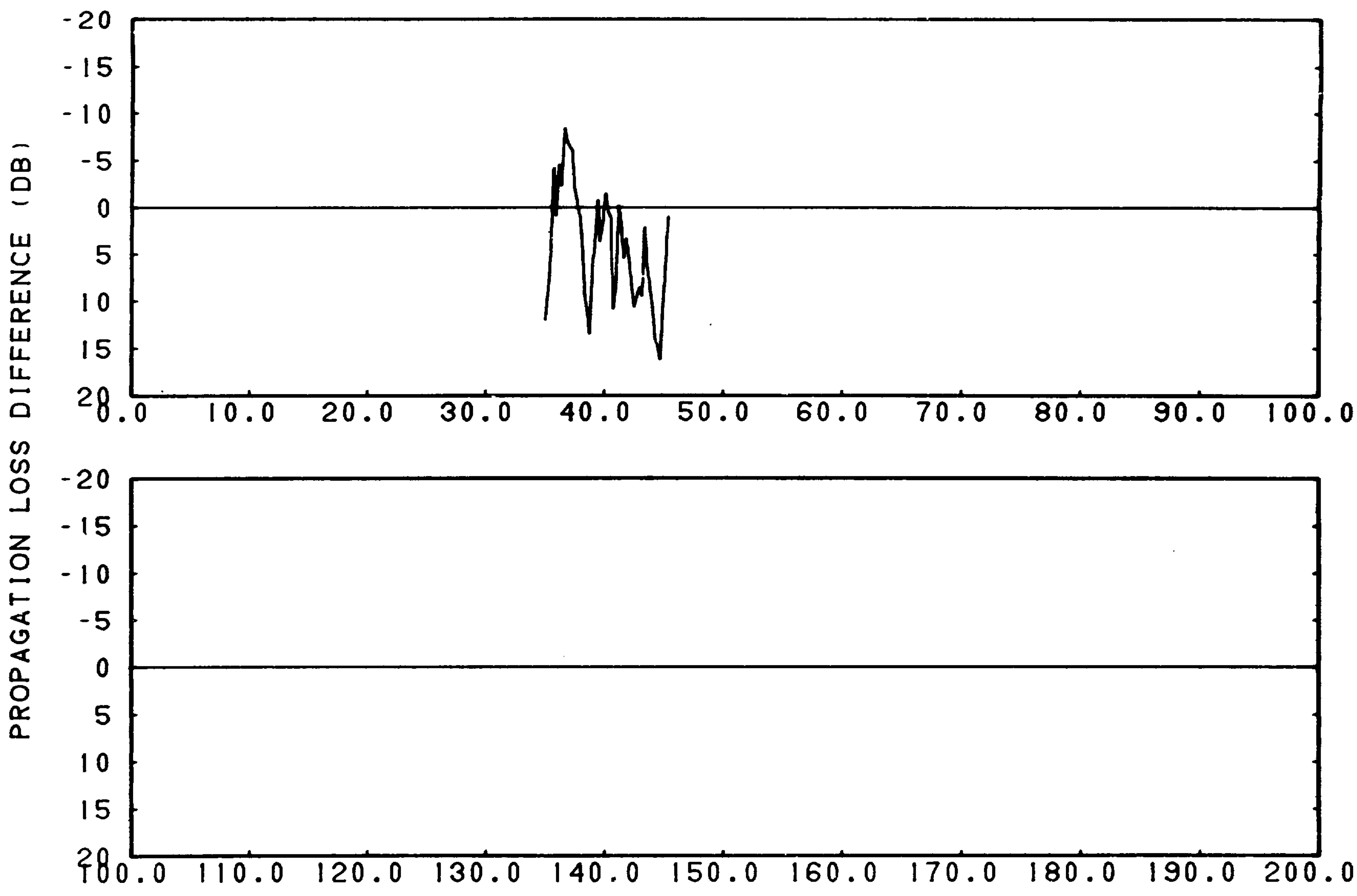
(C) Figure IIF-8f. FACT Semi-coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Siding Averages of 3 Points (0.43 Kilometer)



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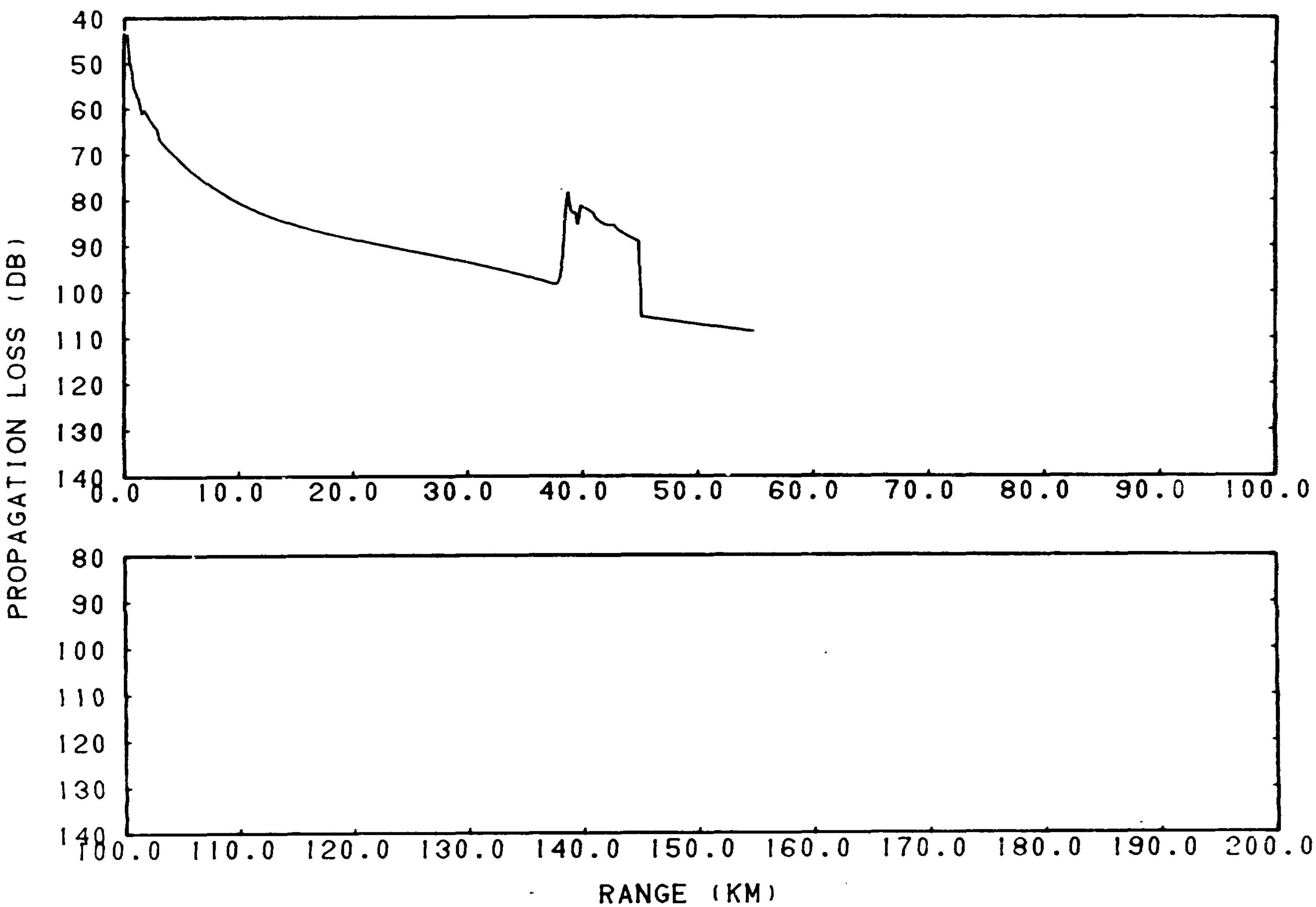
(C) Figure IIF-8g. Smoothed FACT Semi-coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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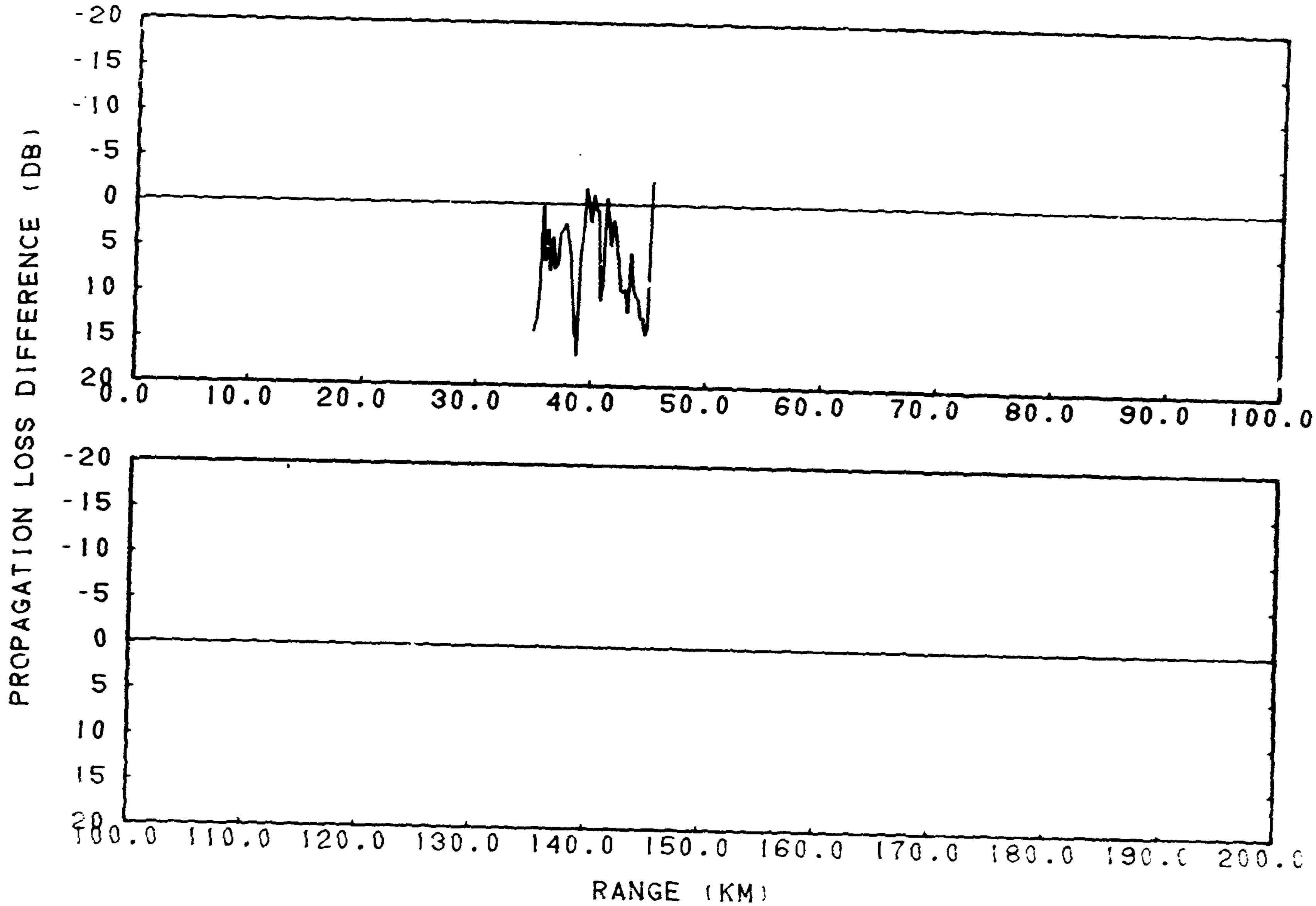
(C) Figure IIF-8h. FACT Incoherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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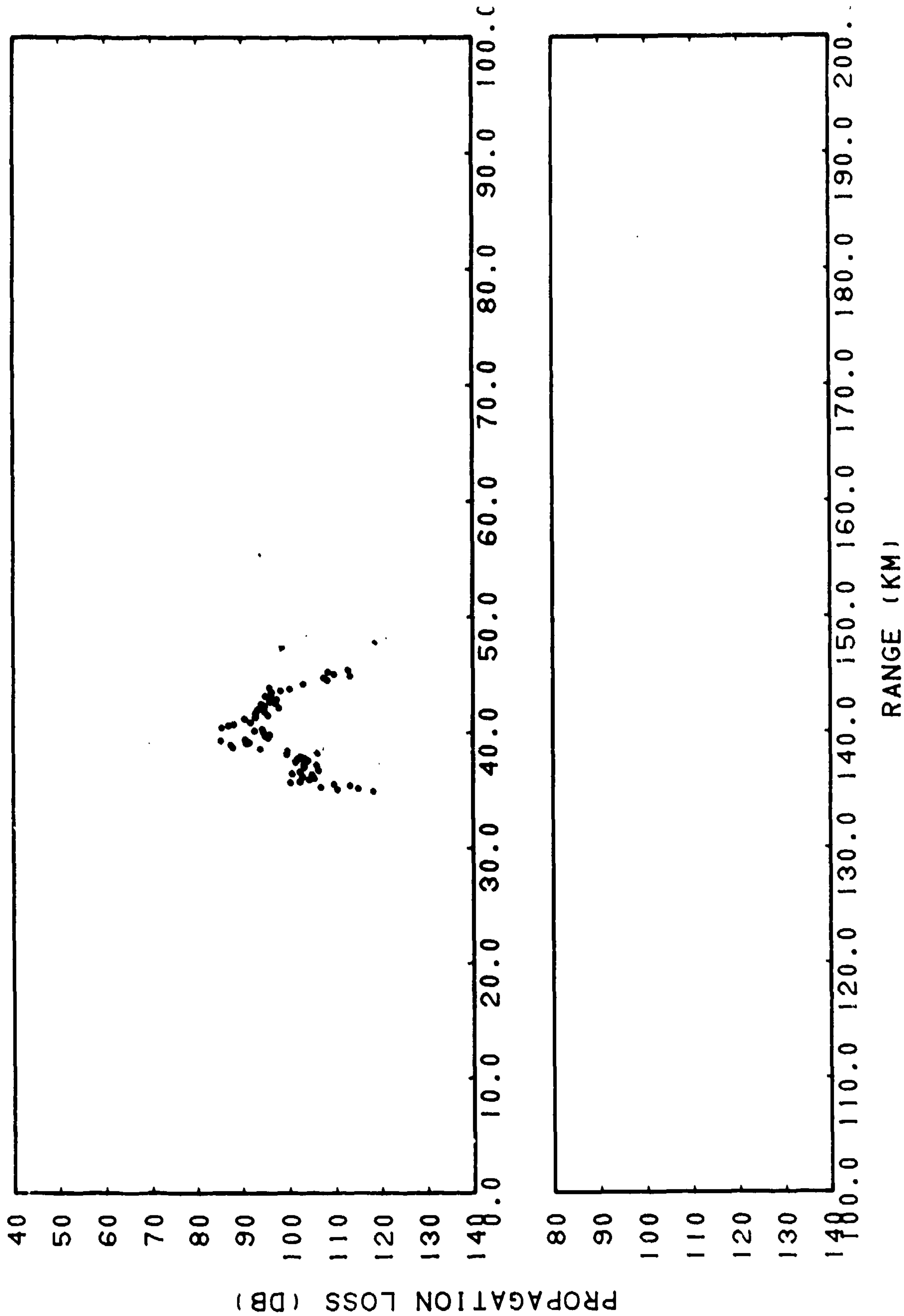
(C) Figure IIF-8i. FACT Incoherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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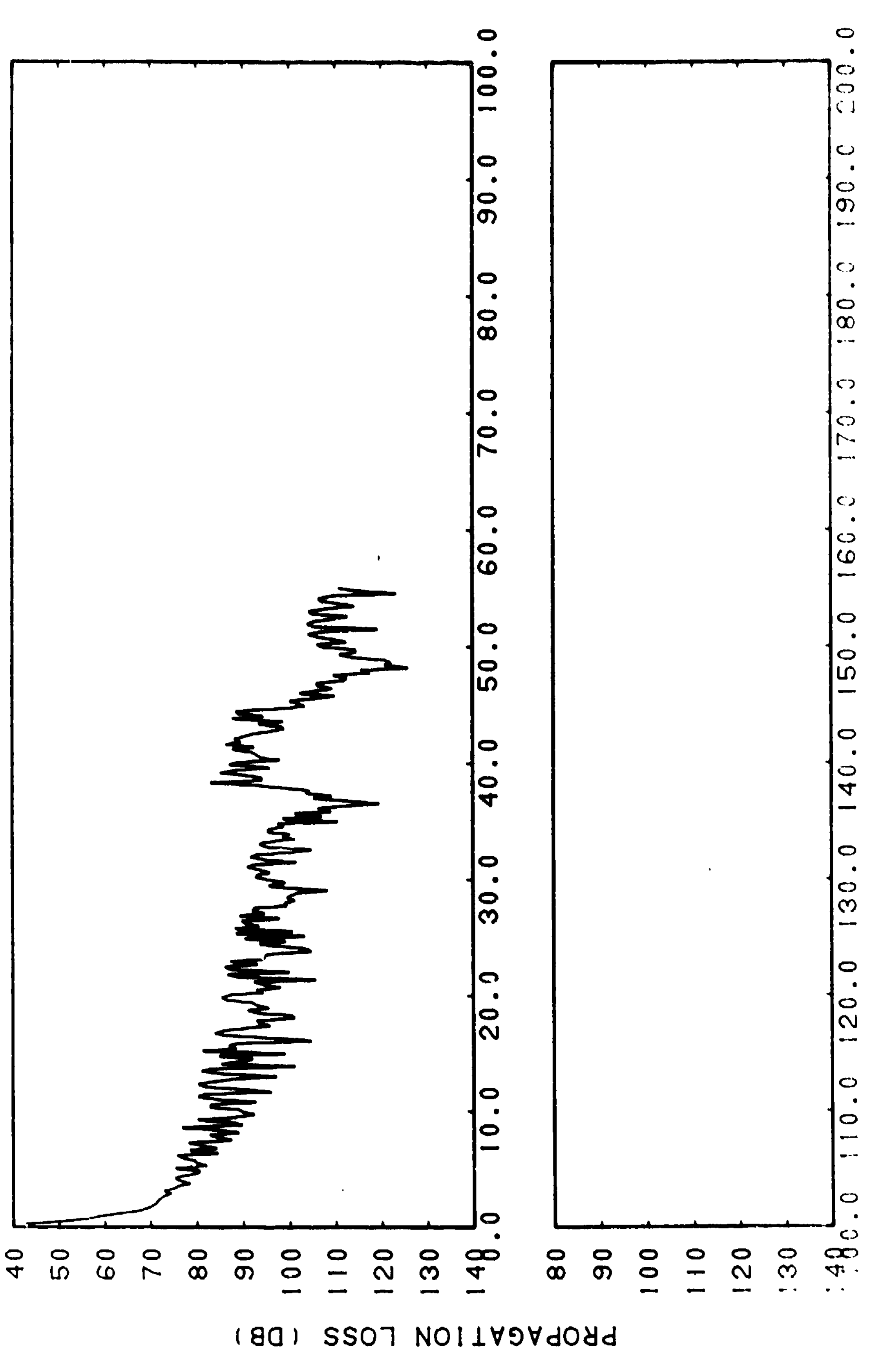
(C) Figure IIF-9a. Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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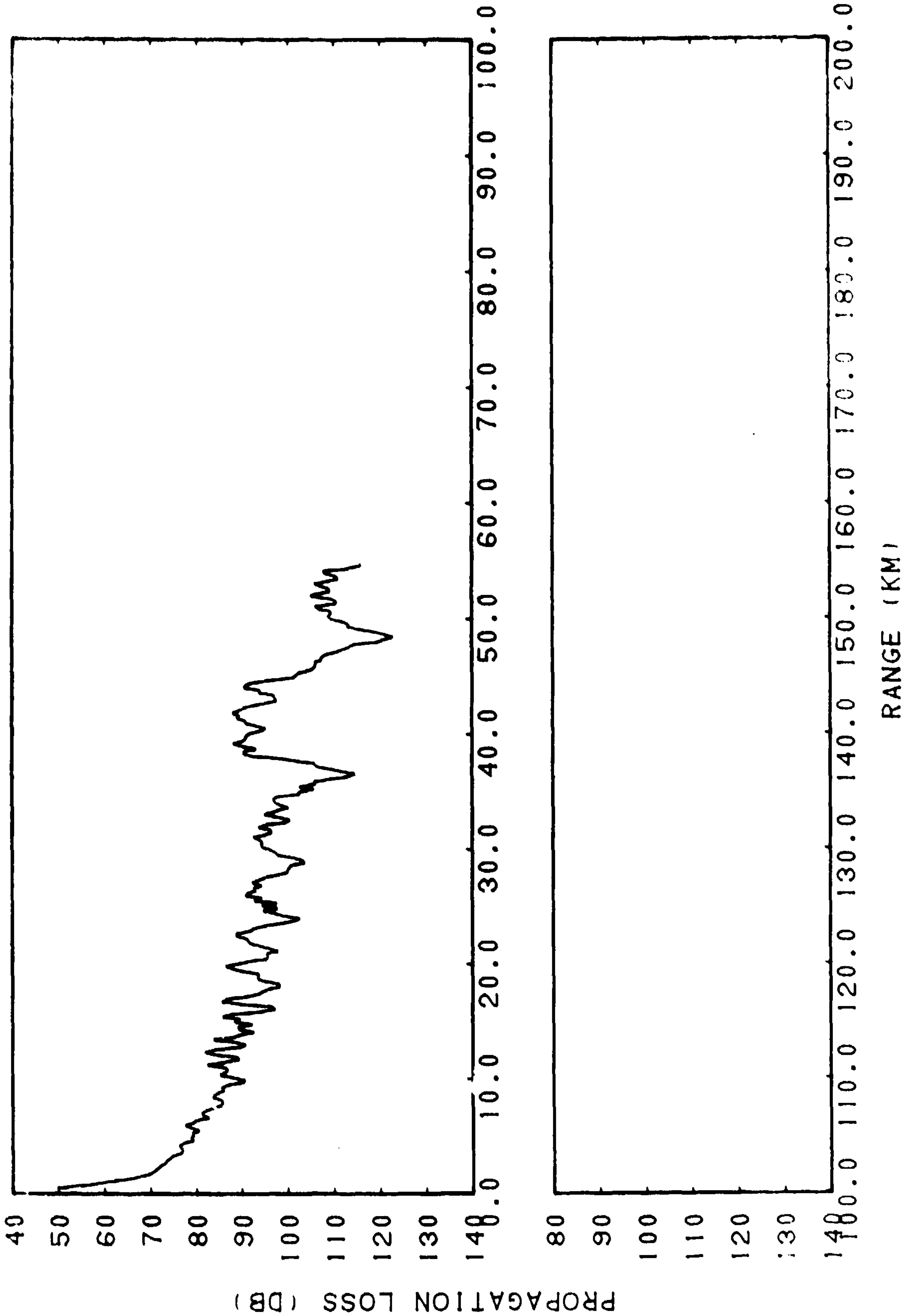
(C) Figure IIF-9b. FACT Coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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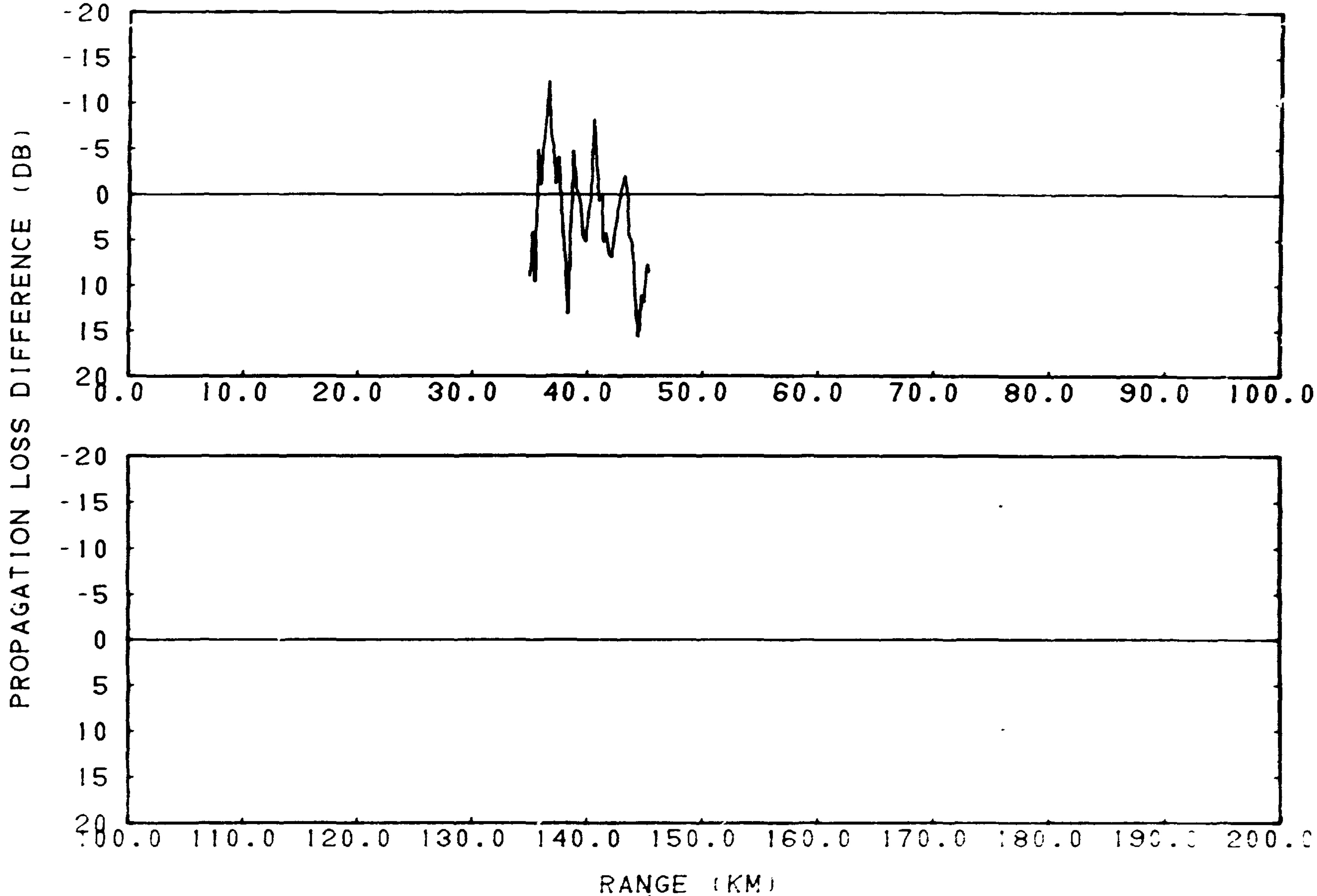
(C) Figure IIF-9c. FACT Coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



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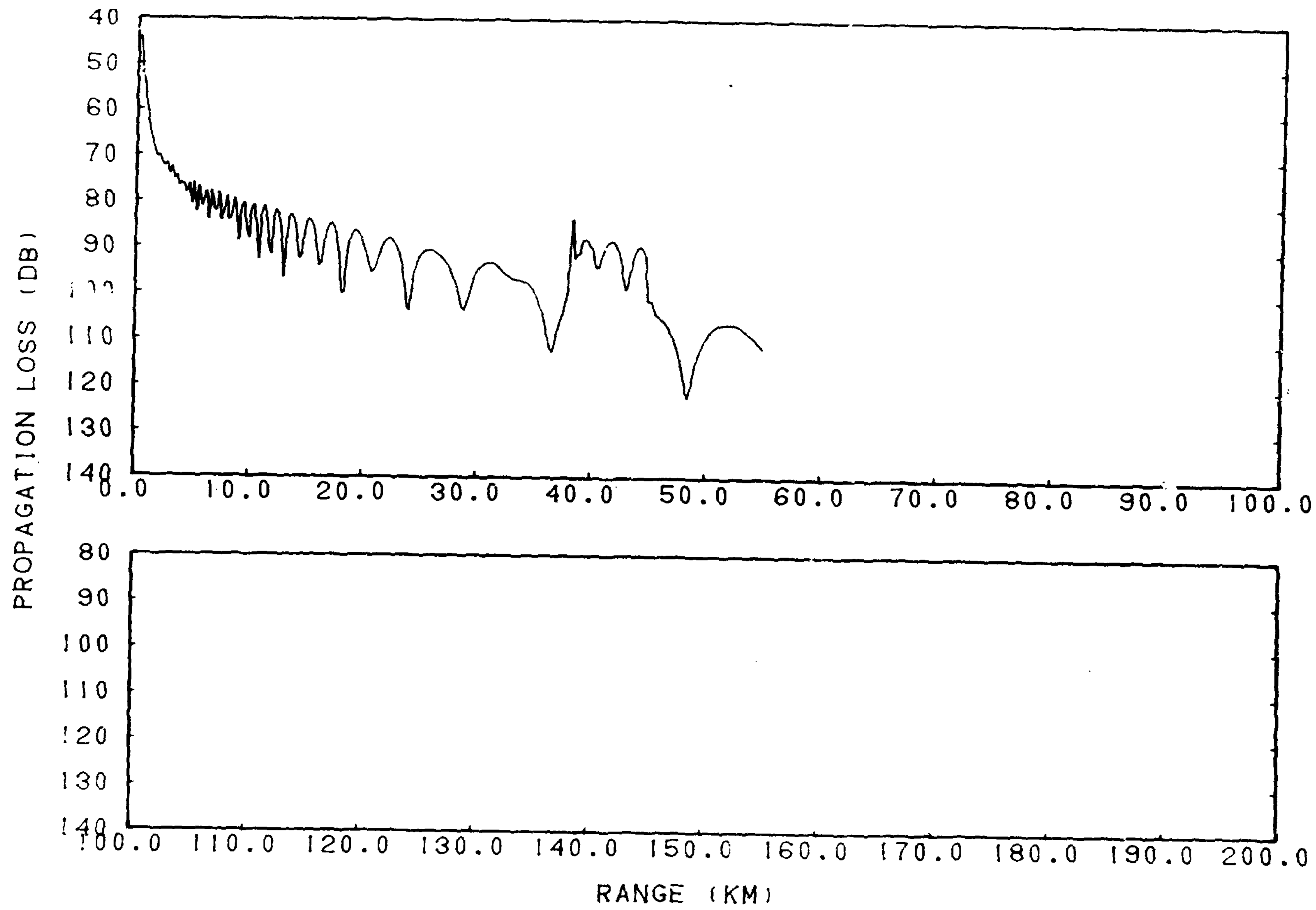
(C) Figure IIF-9d. Smoothed FACT Coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Subtracted from Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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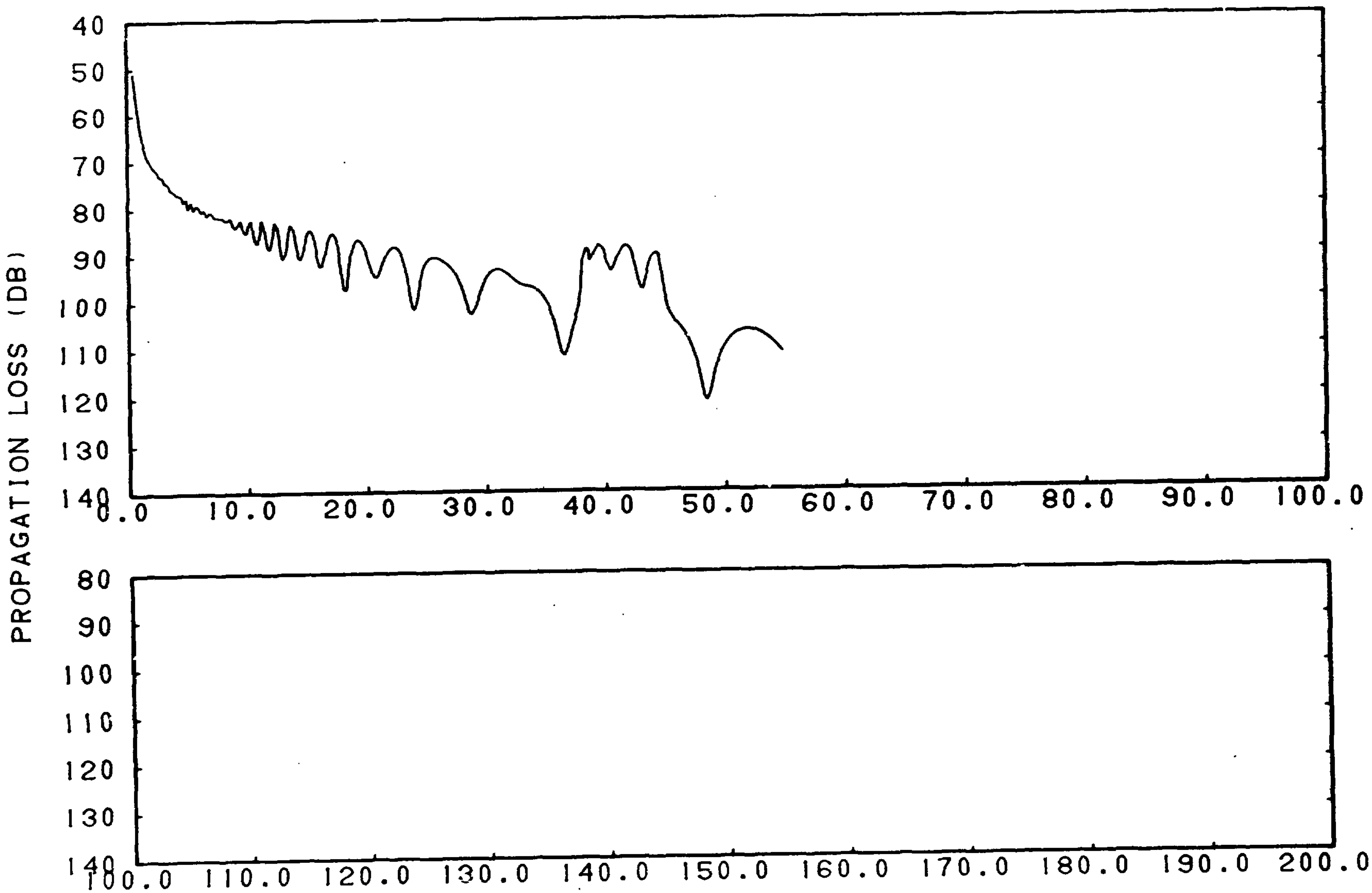
(C) Figure IIF-9e. FACT Semi-coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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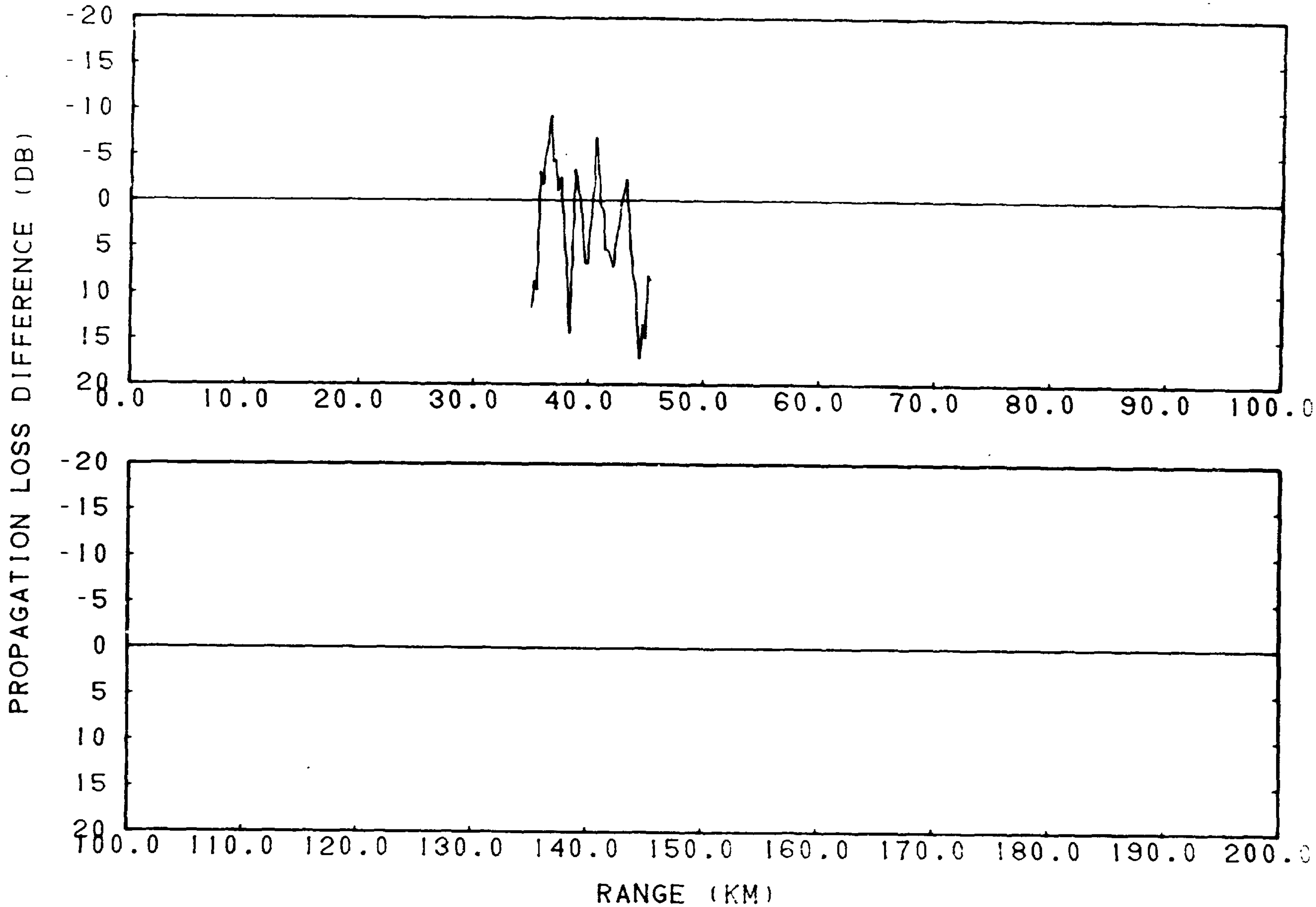
(C) Figure IIF-9f. FACT Semi-coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



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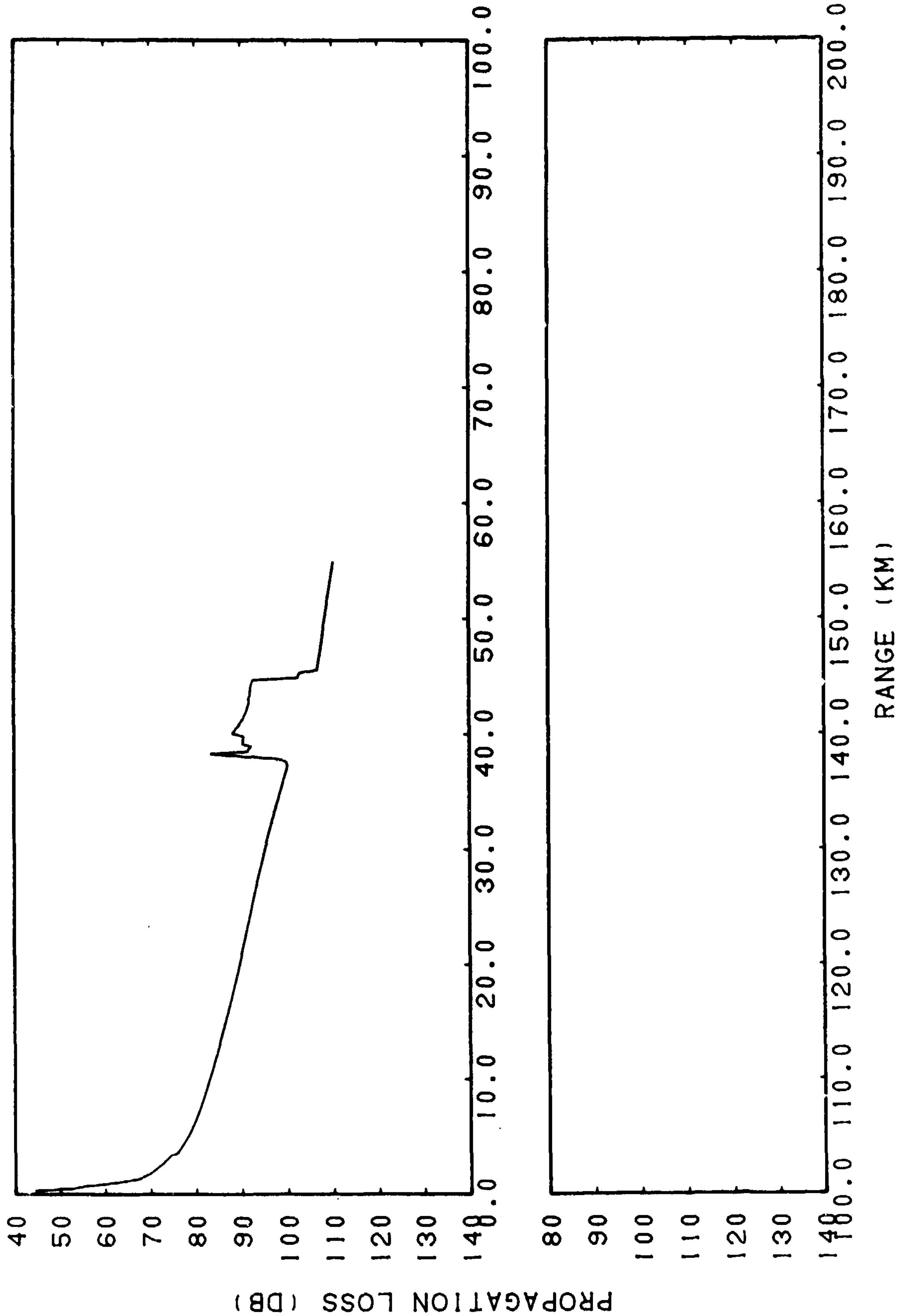
(C) Figure IIF-9g. Smoothed FACT Semi-coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Subtracted from Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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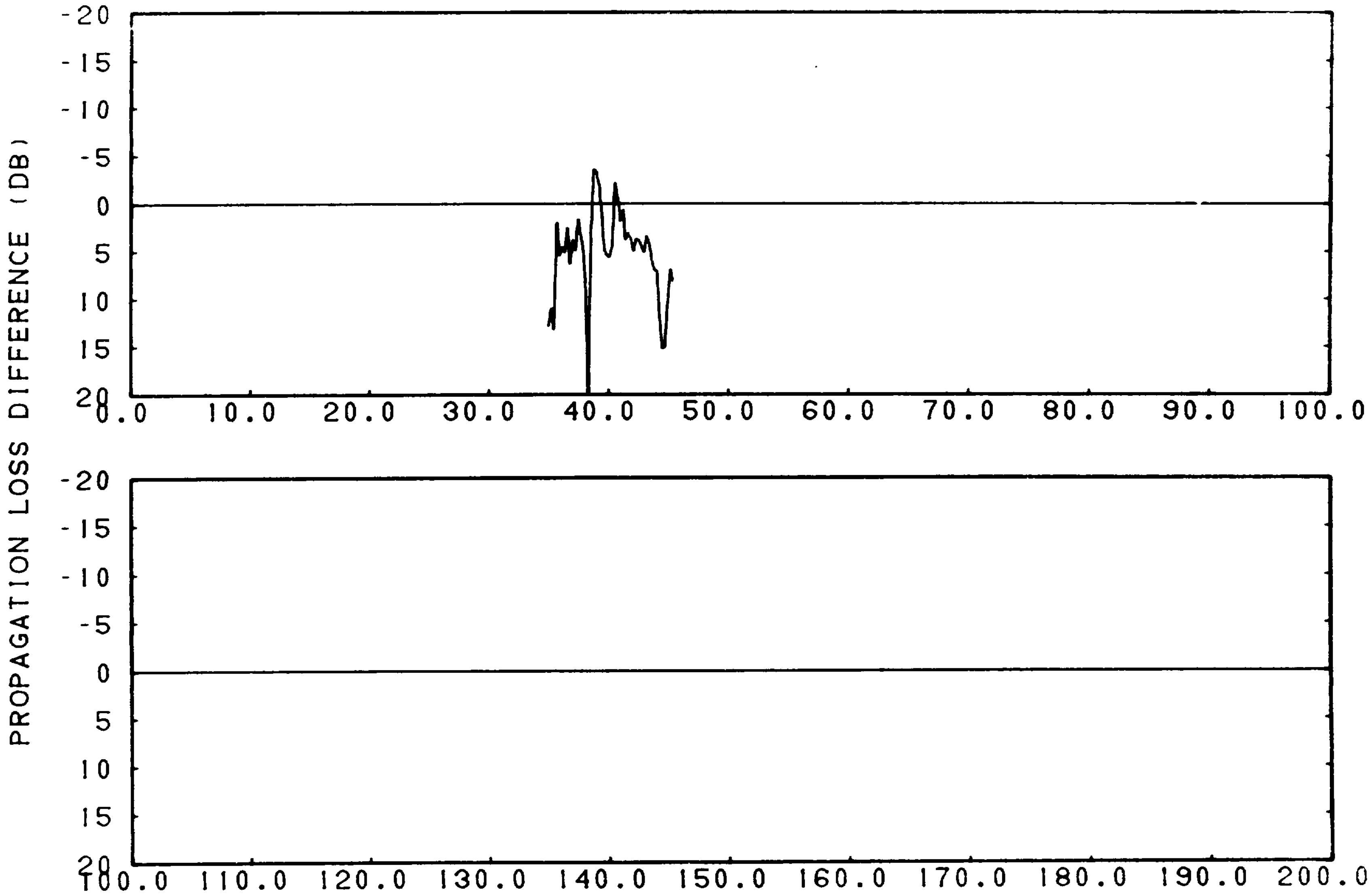
(C) Figure IIF-9h. FACT Incoherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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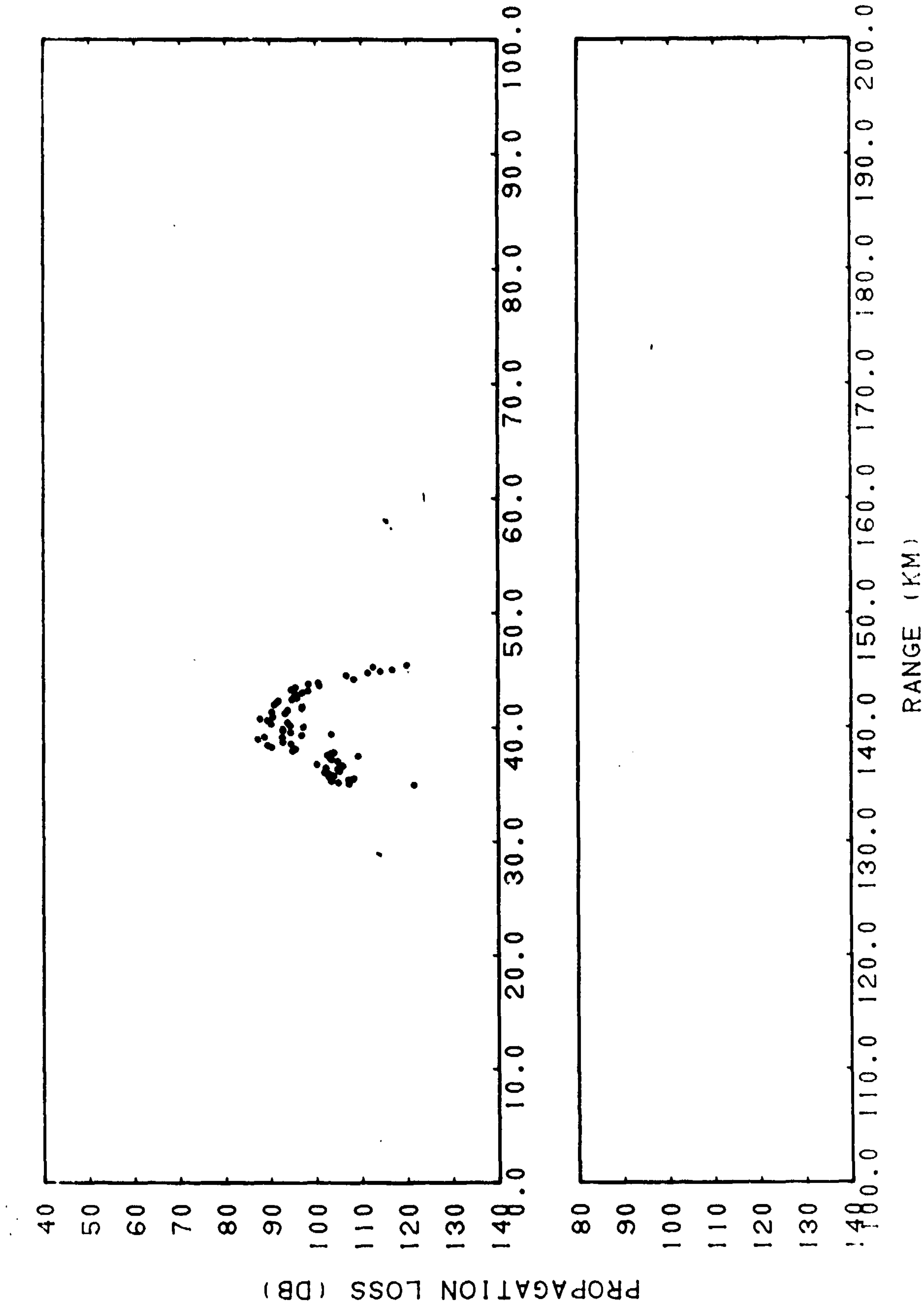
(C) Figure IIF-9i. FACT Incoherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Subtracted from Station 1 Run 43, Source Depth = 20 Feet Receiver Depth = 260 Feet



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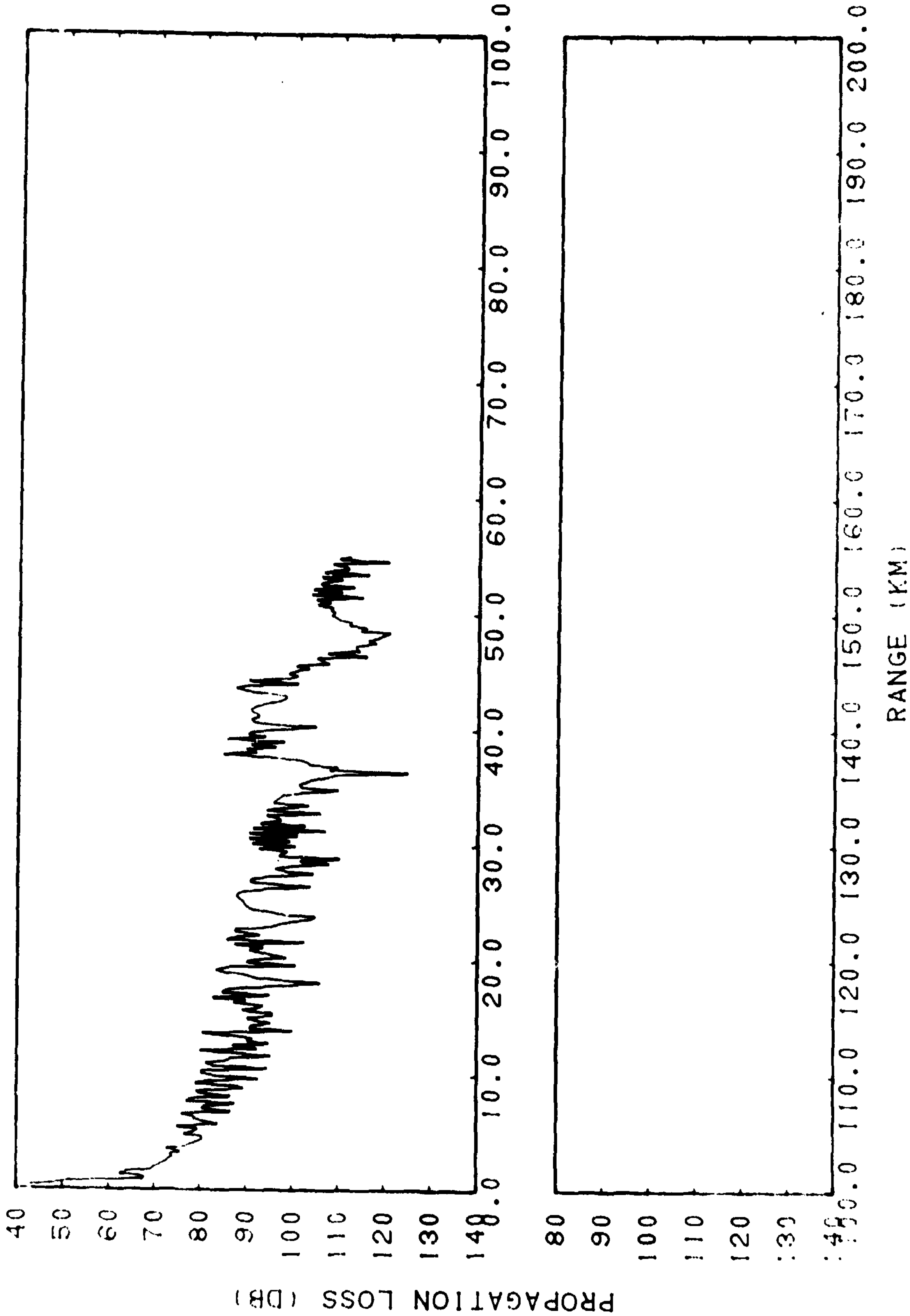
(C) Figure IIF-10a. Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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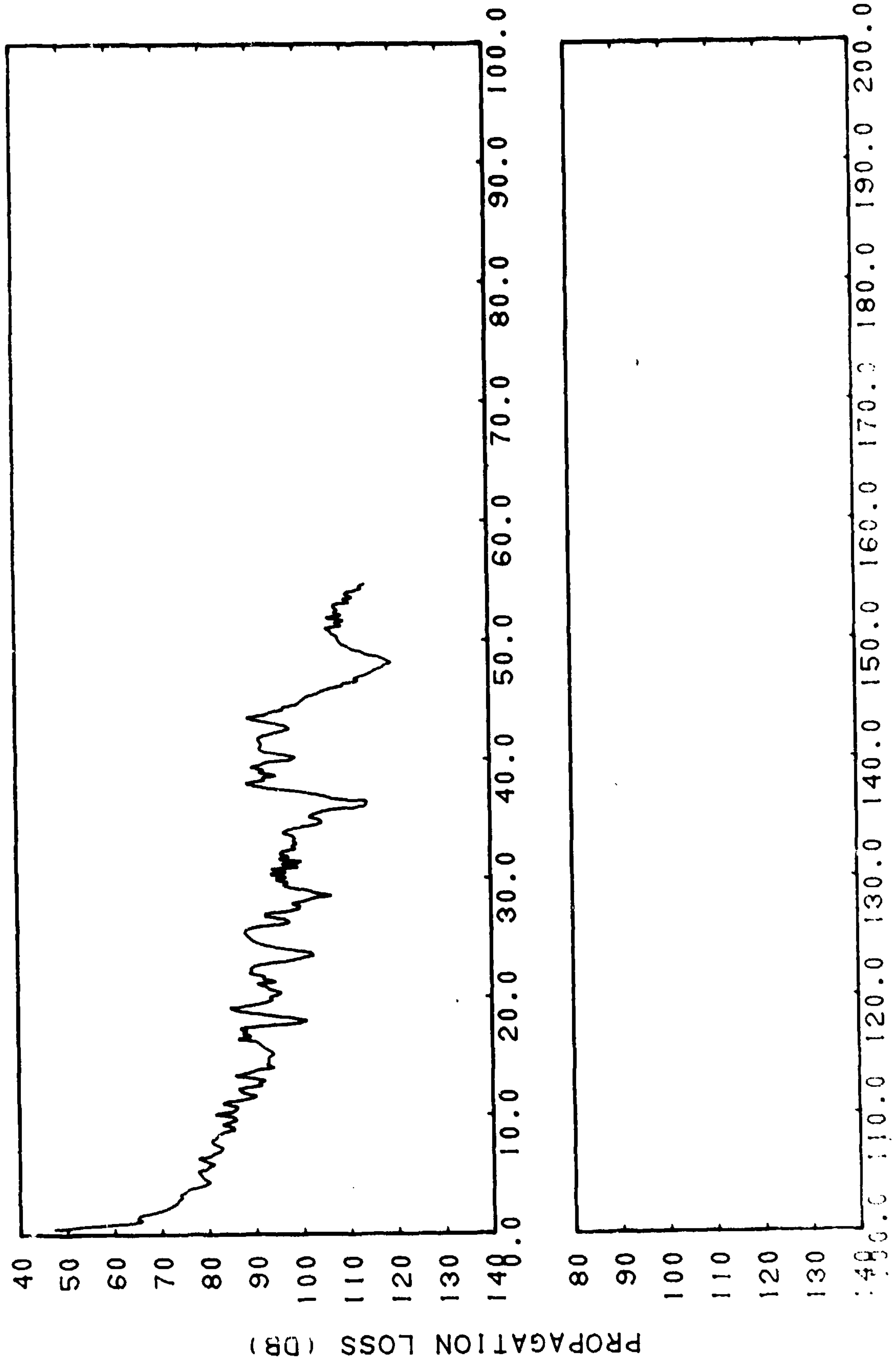
(C)Figure IIF-10b. FACT Coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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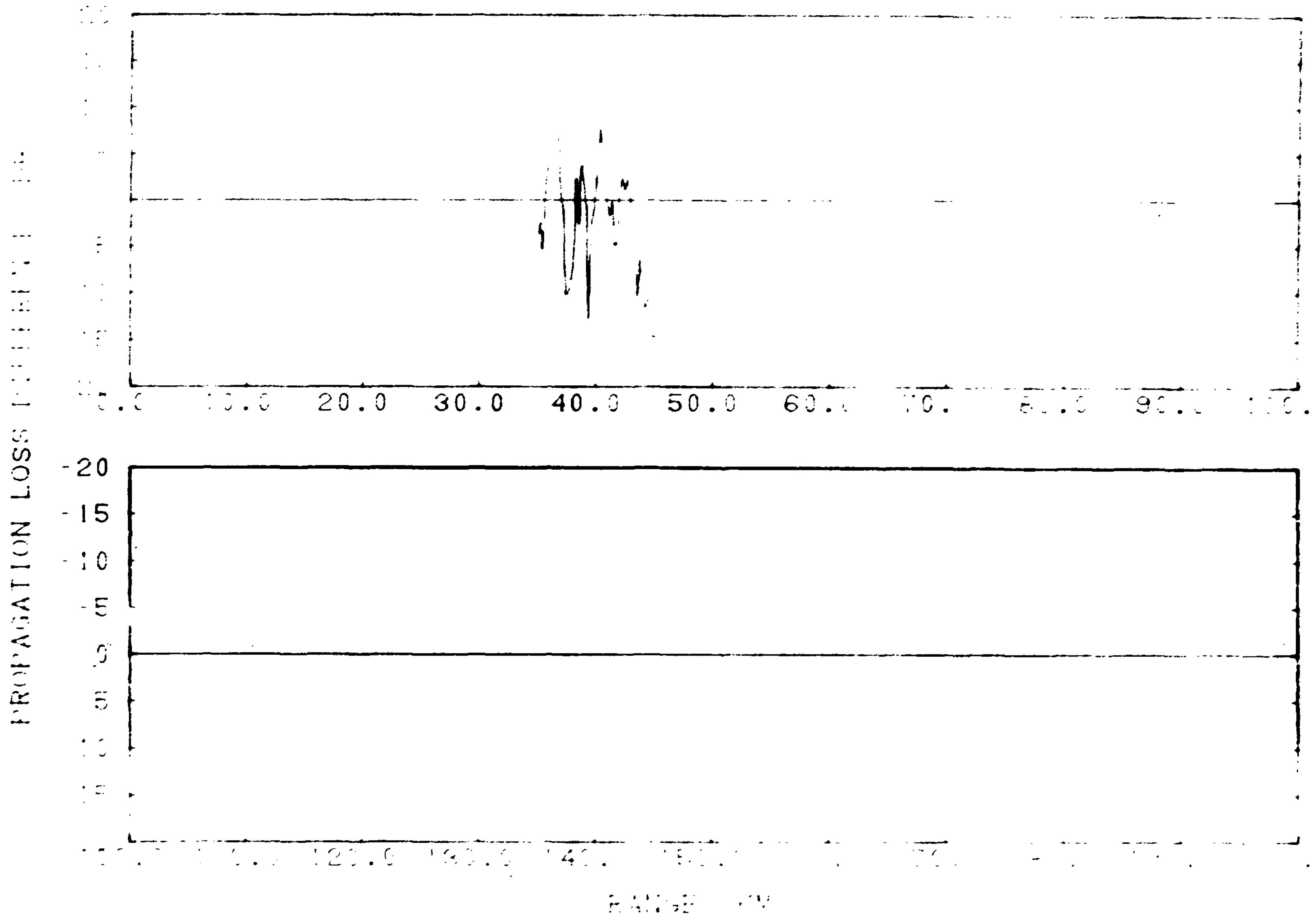
(C) Figure IIF-10c. FACT Coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



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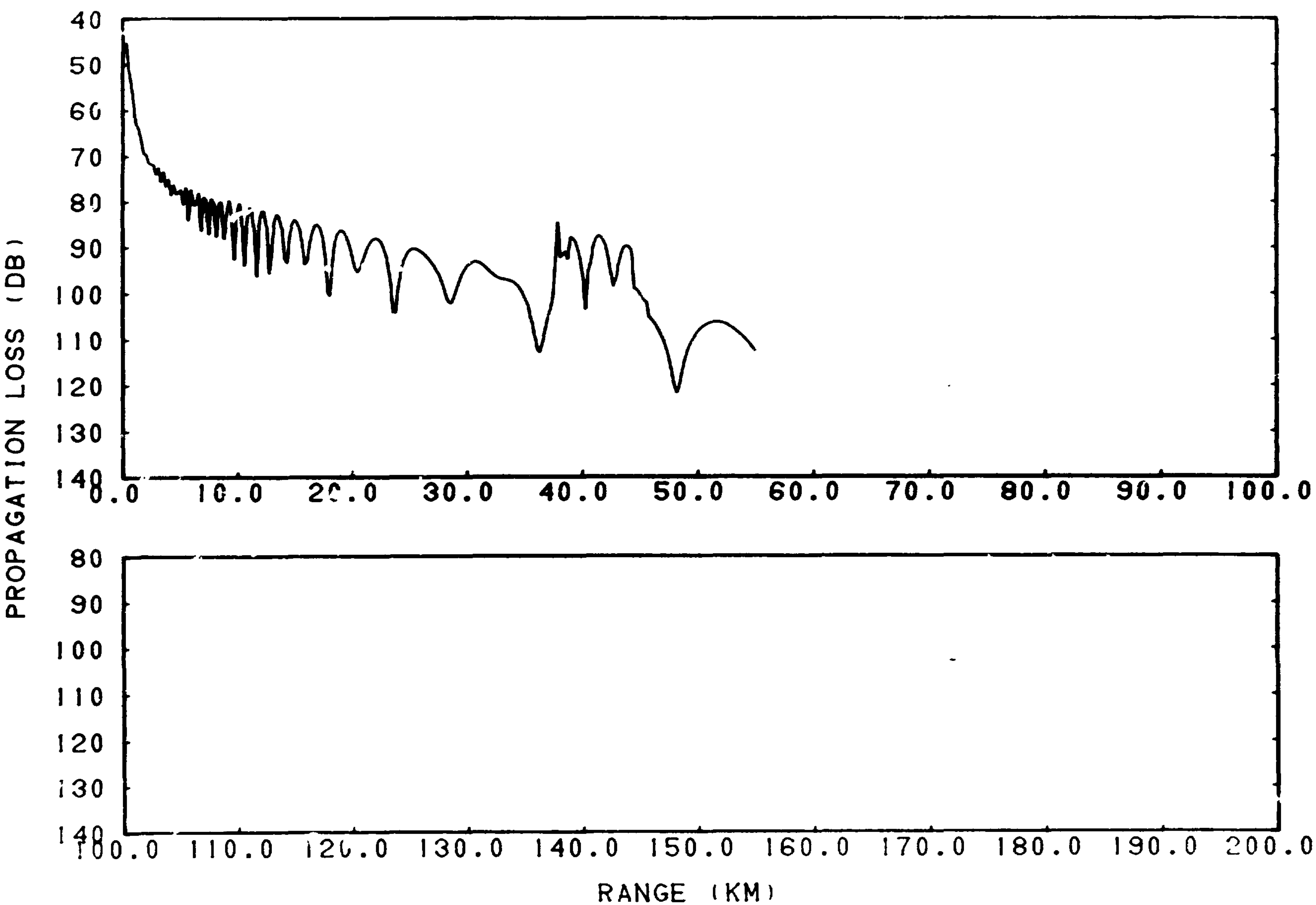
(C) Figure IIF-10d. Smoothed FACT Coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Subtracted from Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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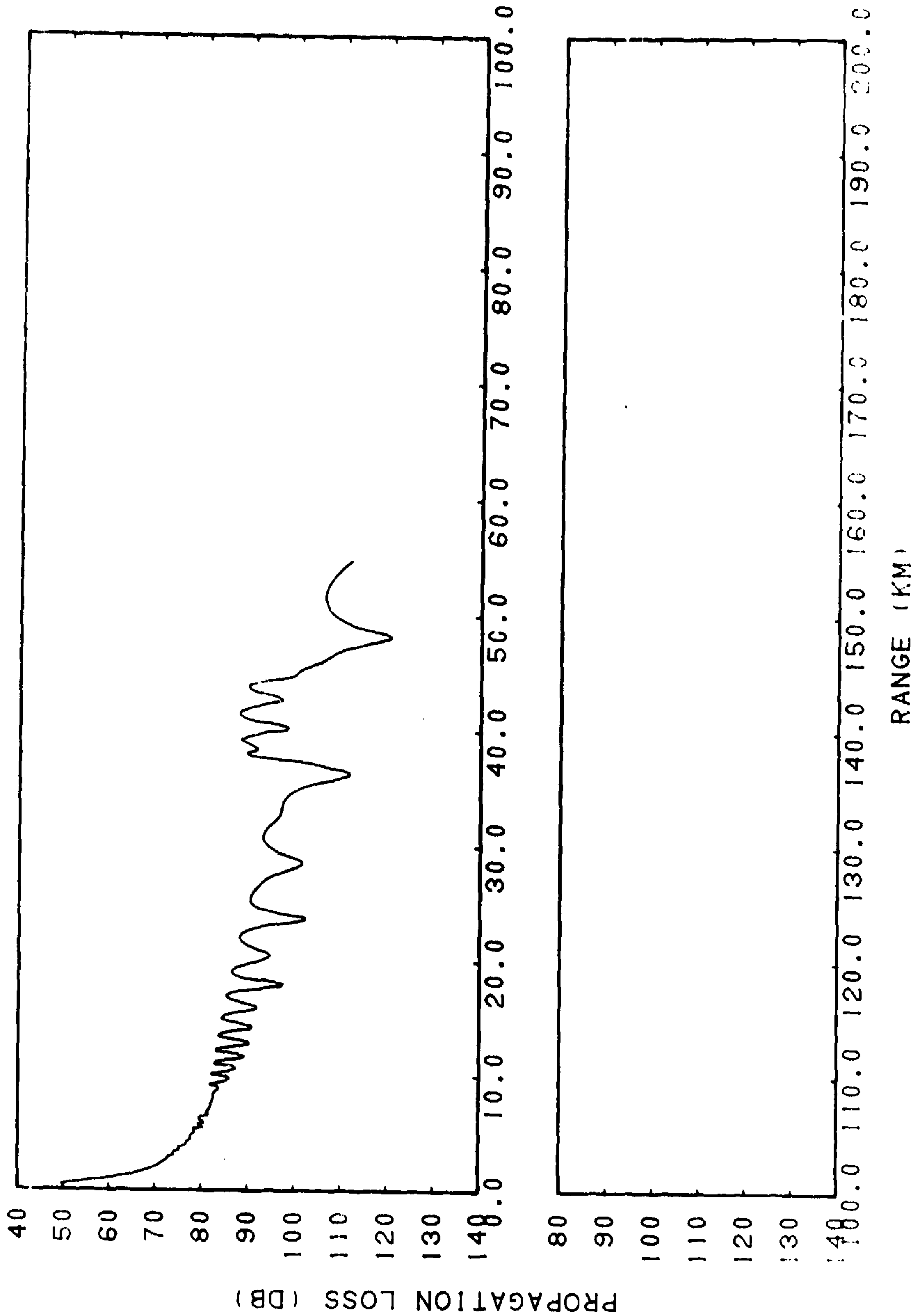
(C) Figure IIF-10e. FACT Semi-coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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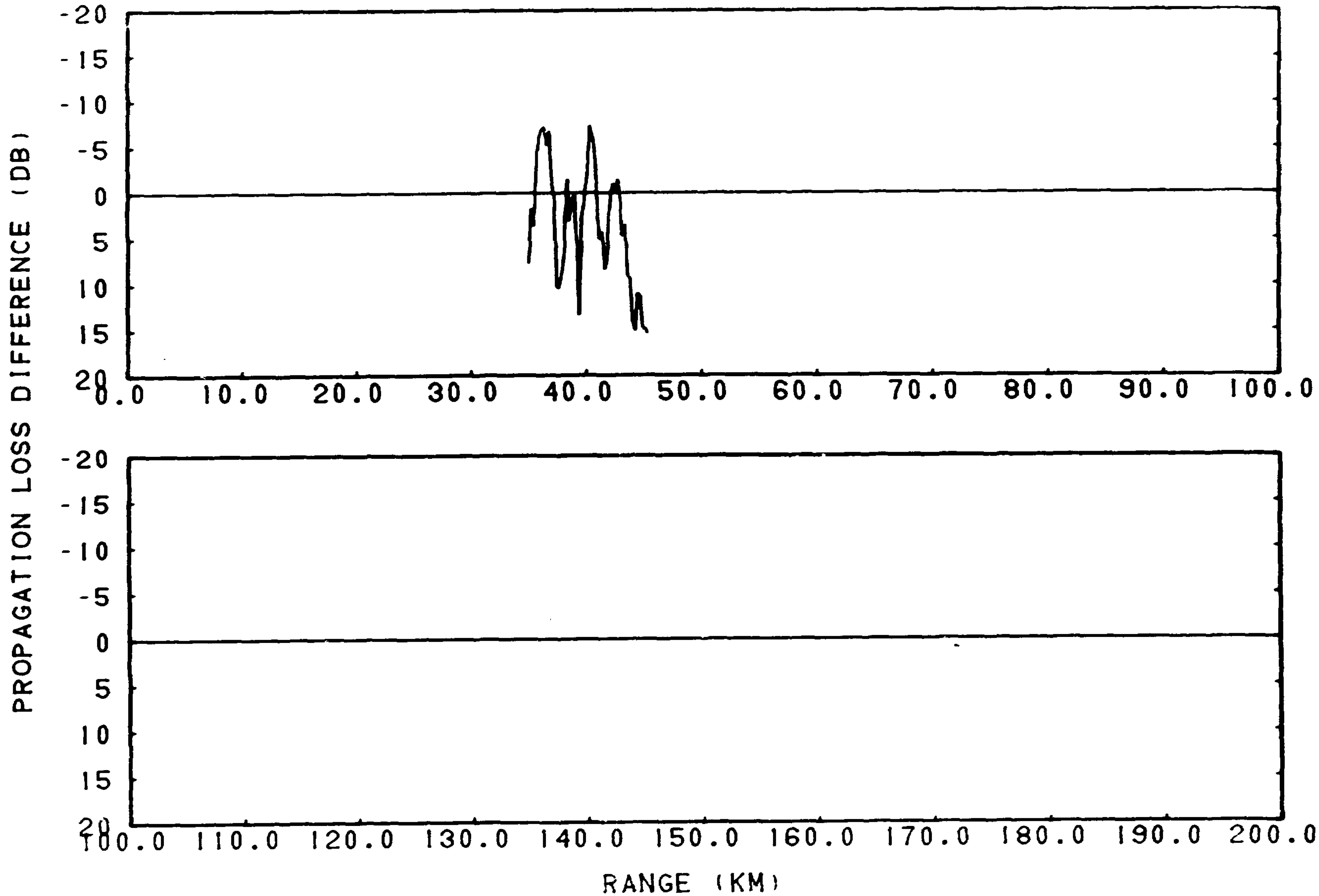
(C) Figure IIF-10f. FACT Semi-coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



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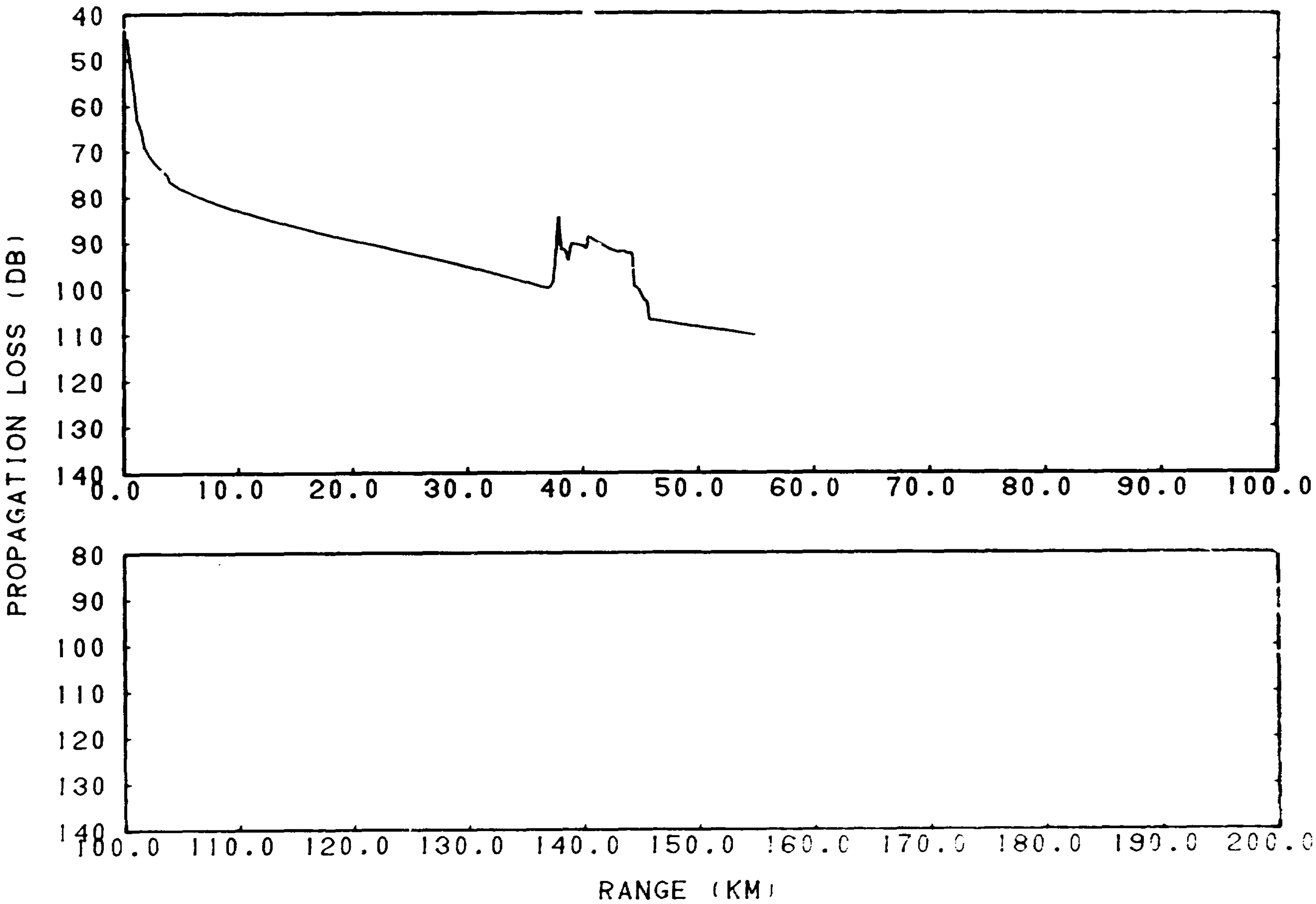
(C) Figure IIF-10g. Smoothed FACT Semi-coherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Subtracted from Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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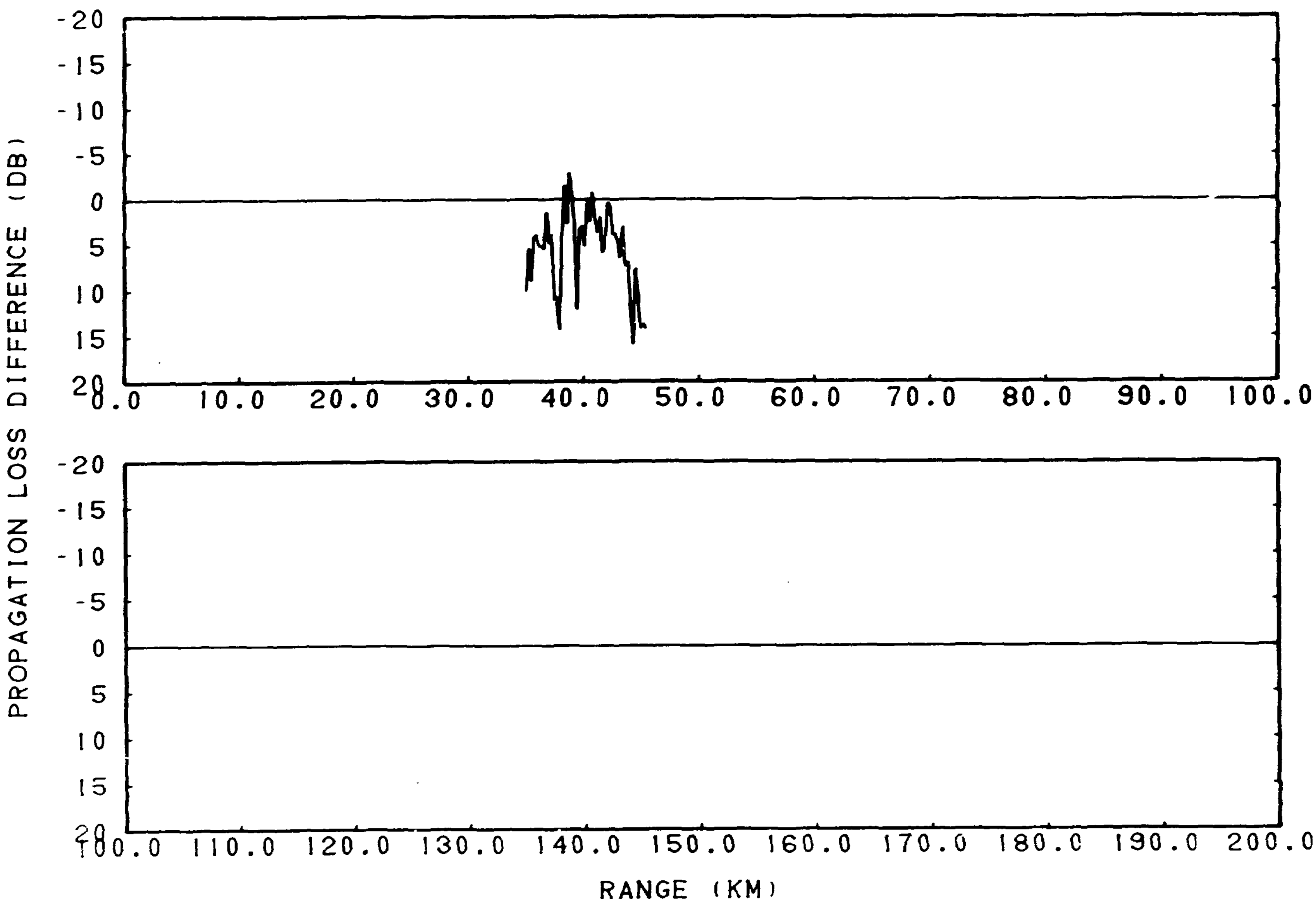
(C) Figure IIF-10h. FACT Incoherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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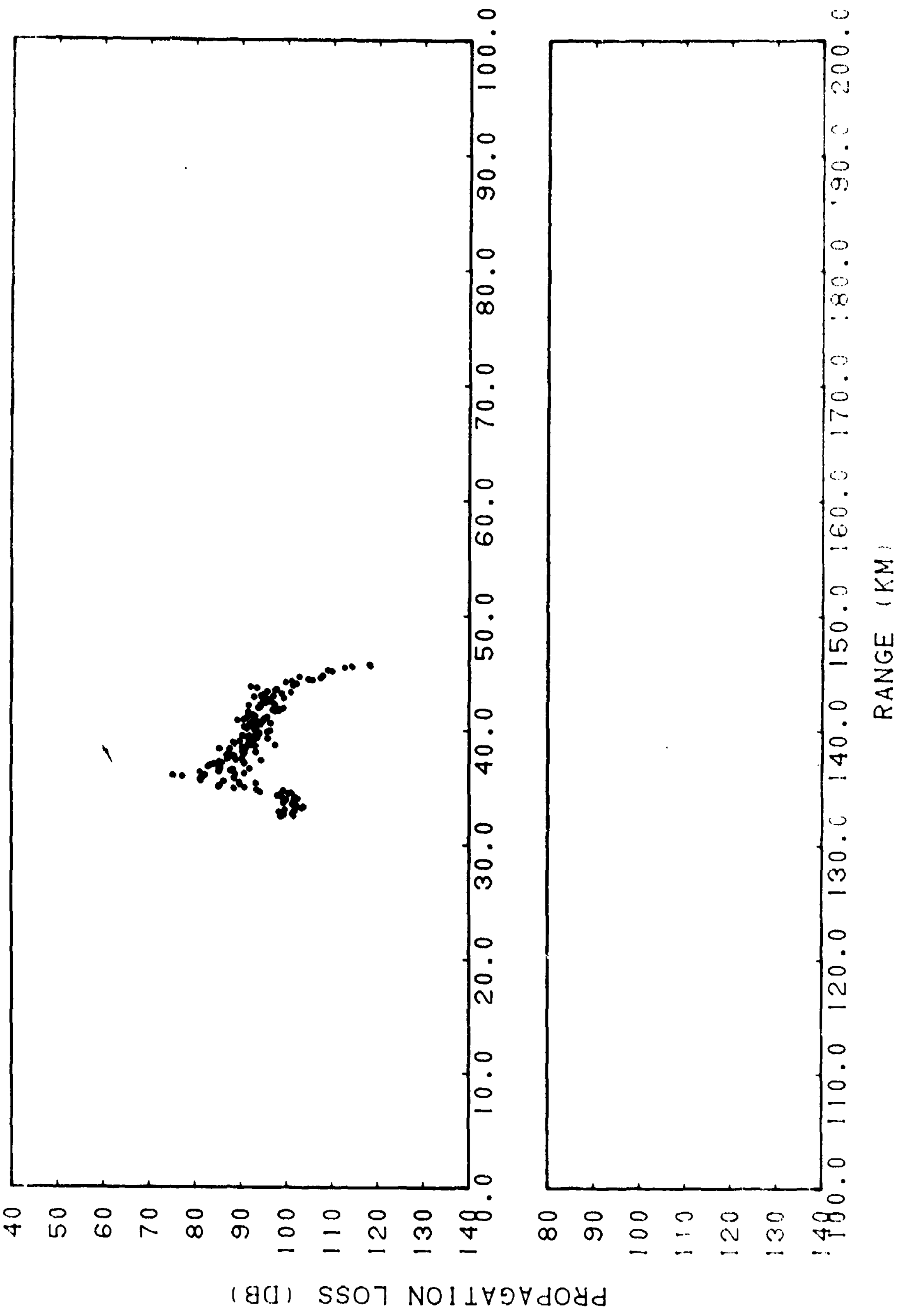
(C) Figure IIF-10i. FACT Incoherent Station 1 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Subtracted from Station 1 Run 43, Scurce Depth = 20 Feet, Receiver Depth = 535 Feet



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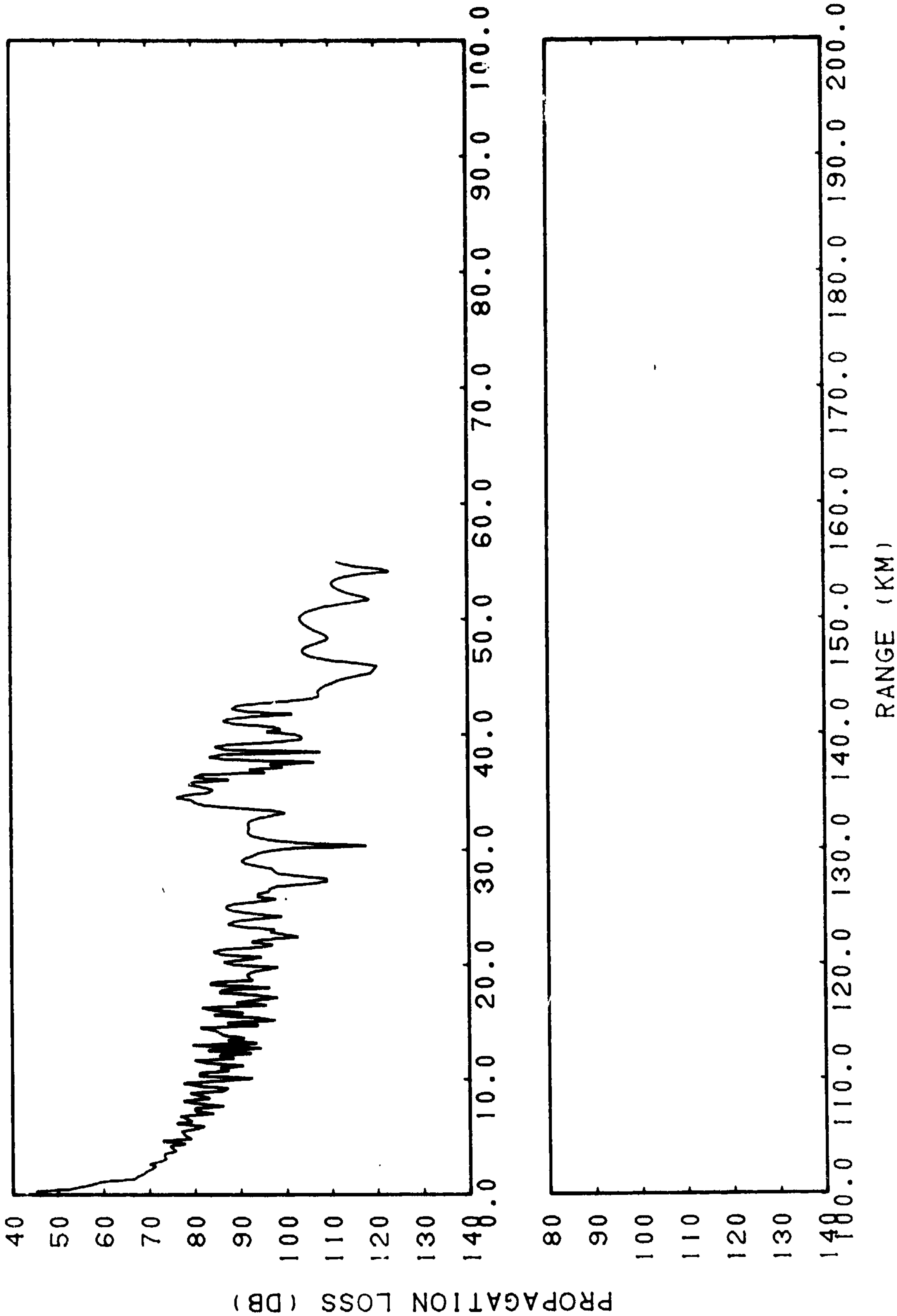
(C) Figure IIF-11a. Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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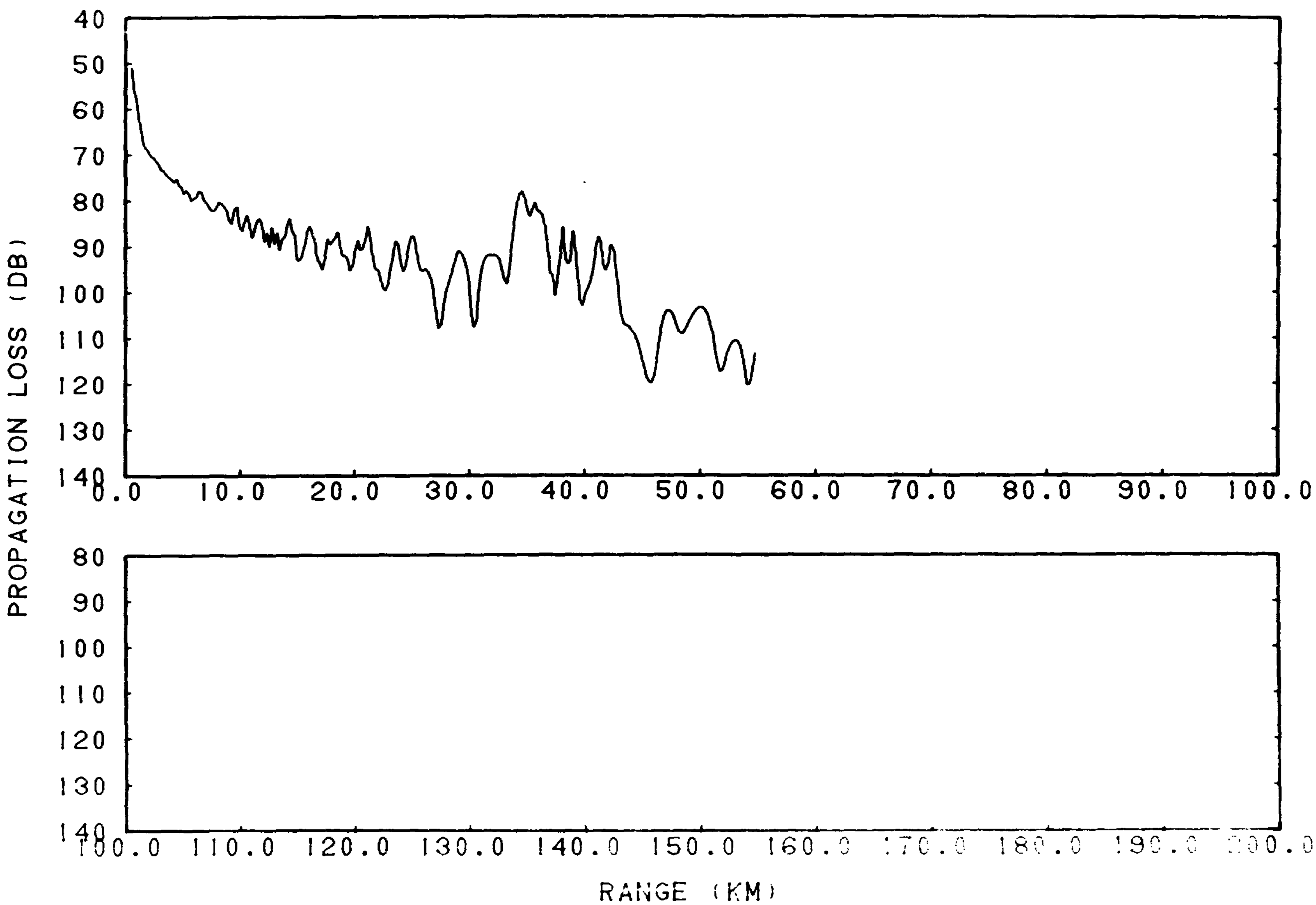
(C) Figure IIF-11b. FACT Coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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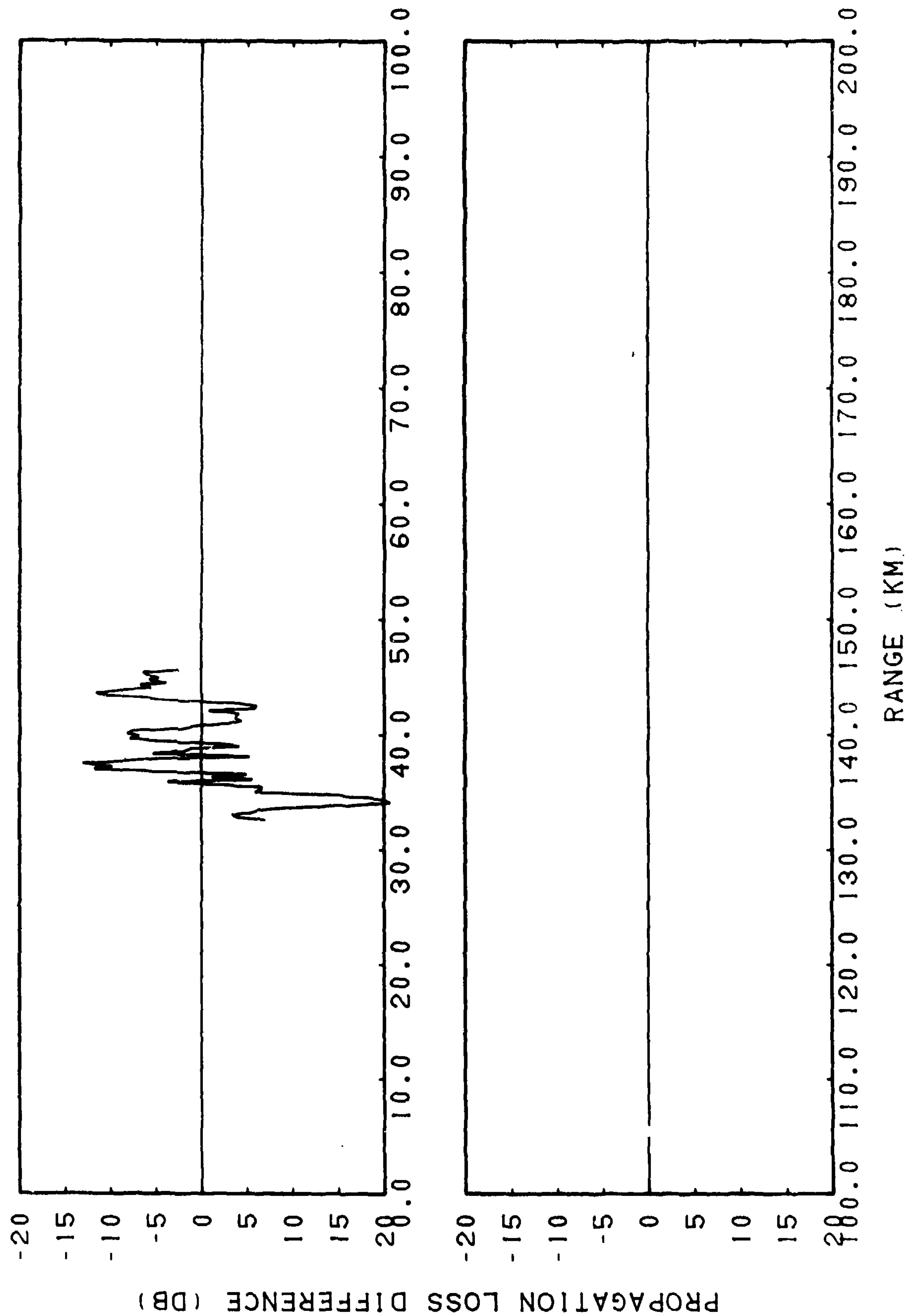
(C) Figure IIF-11c. FACT Coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



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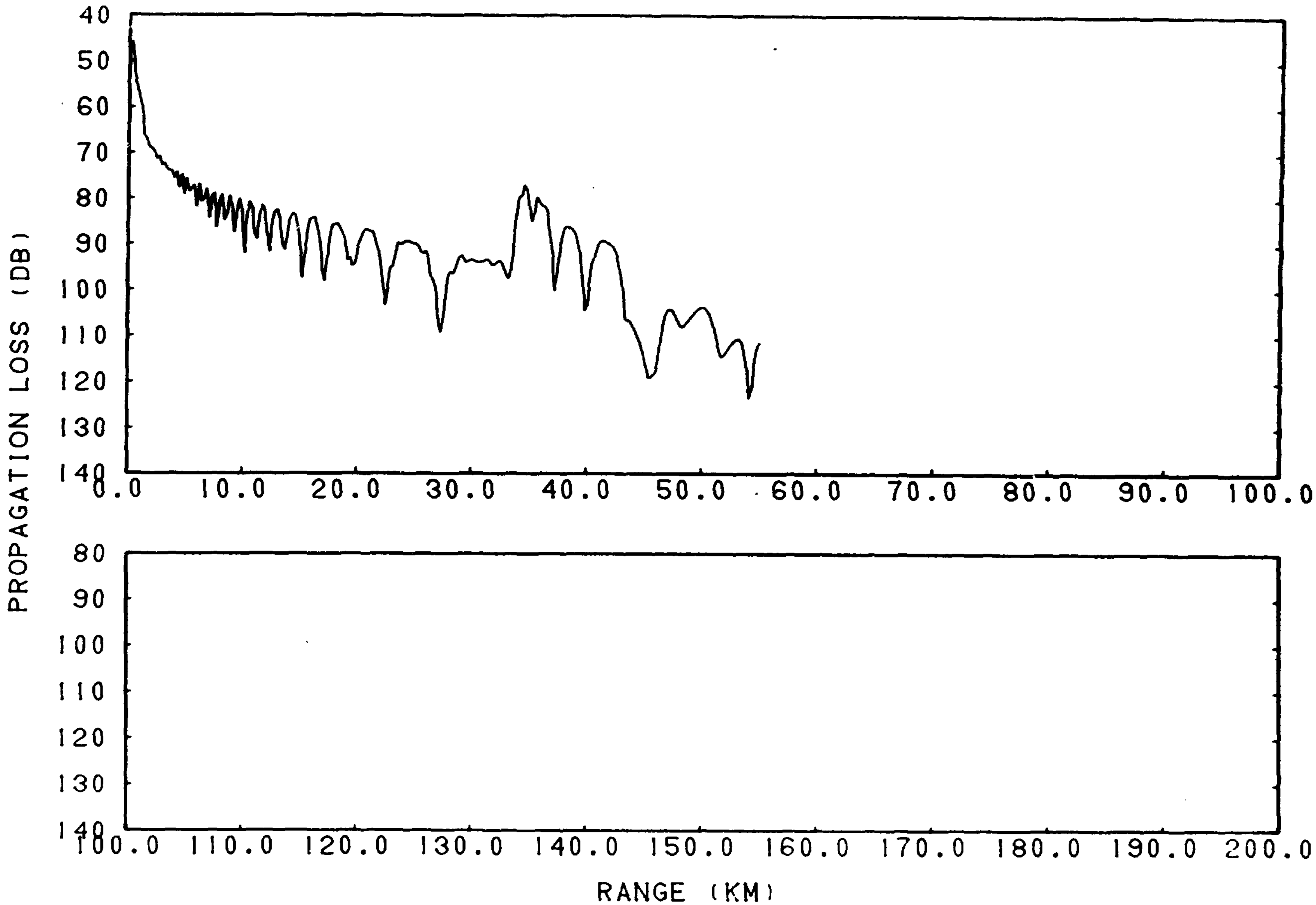
(C) Figure IIF-11d. Smoothed FACT Coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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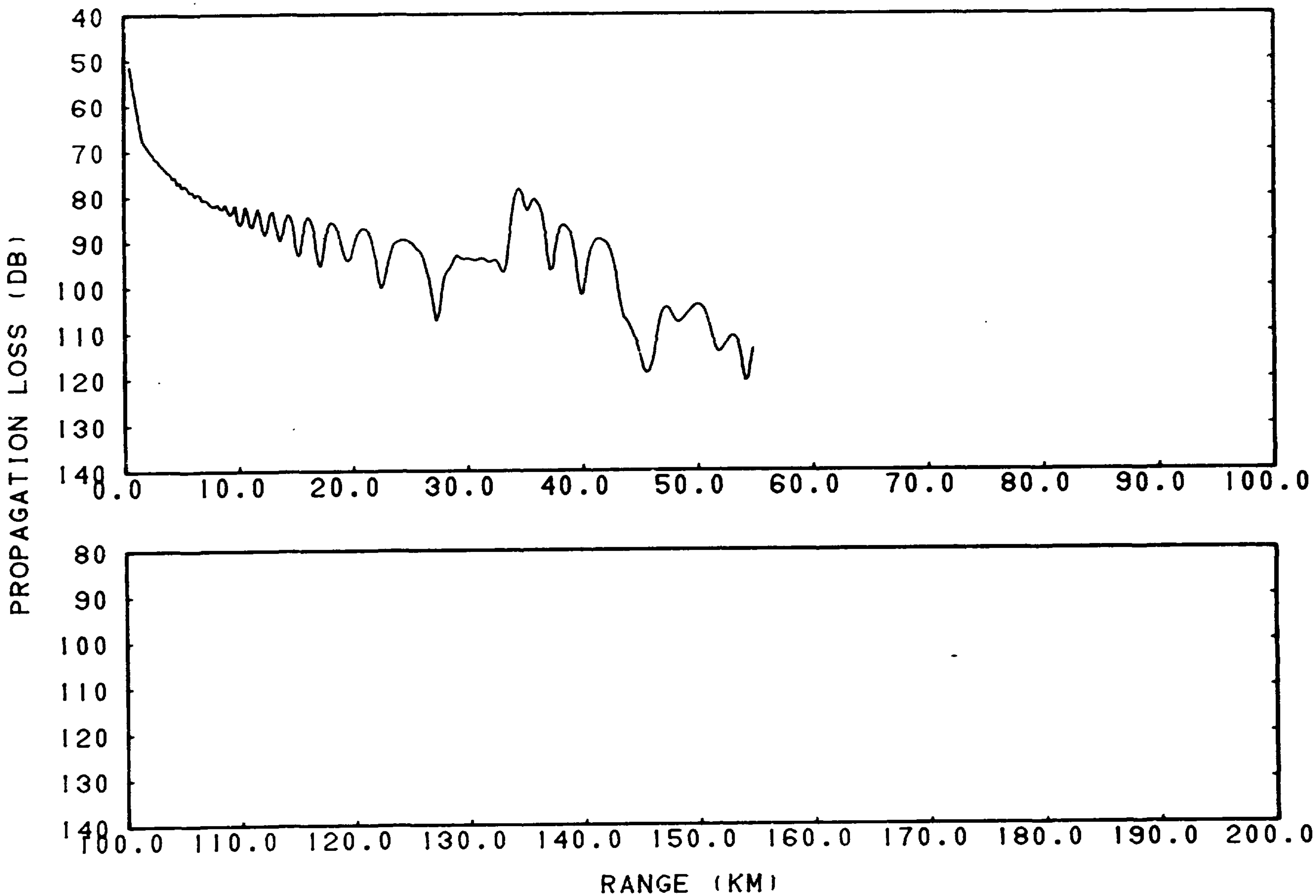
(C) Figure IIF-11e. FACT Semi-coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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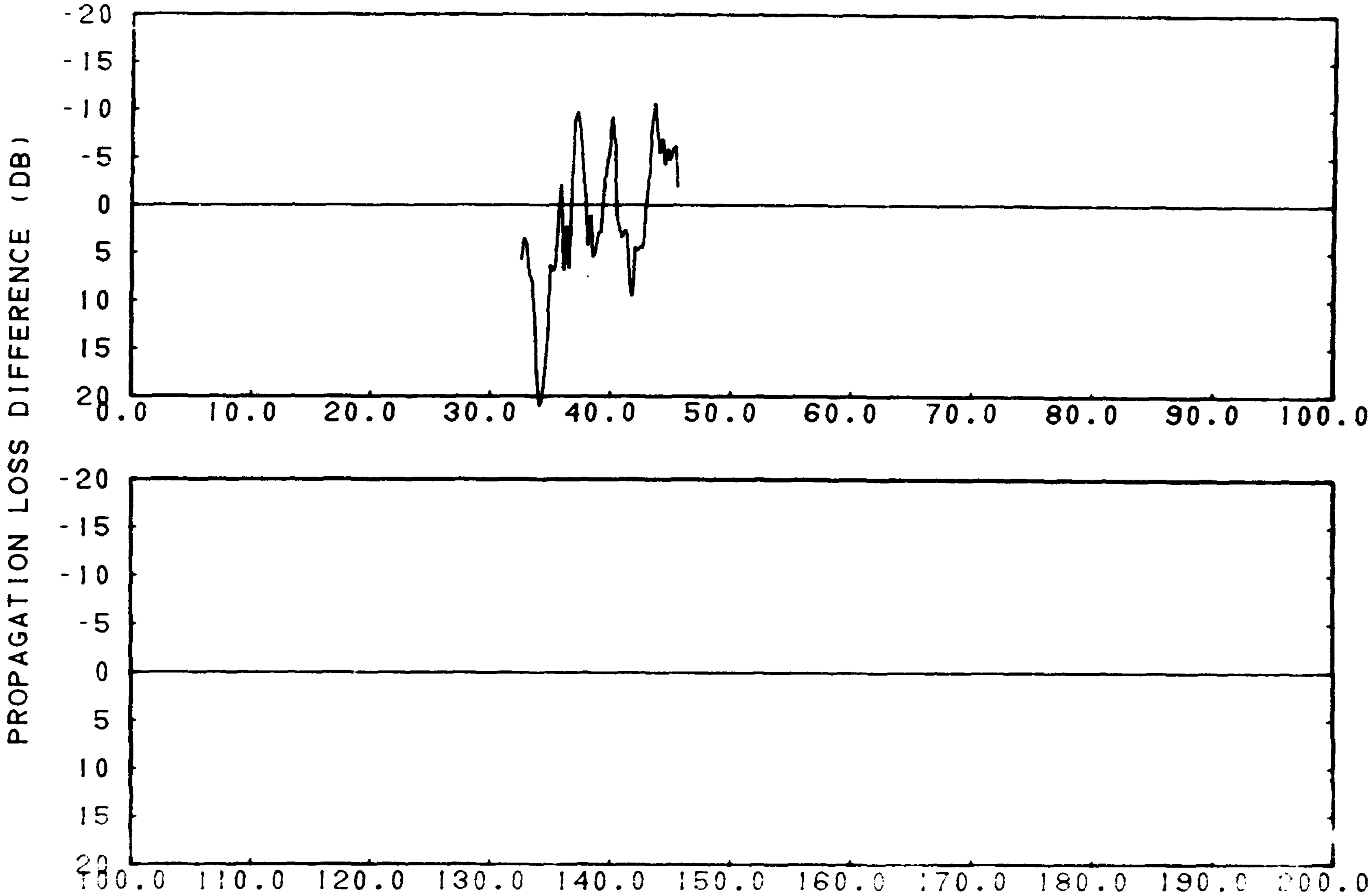
(C) Figure IIF-11f. FACT Semi-coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



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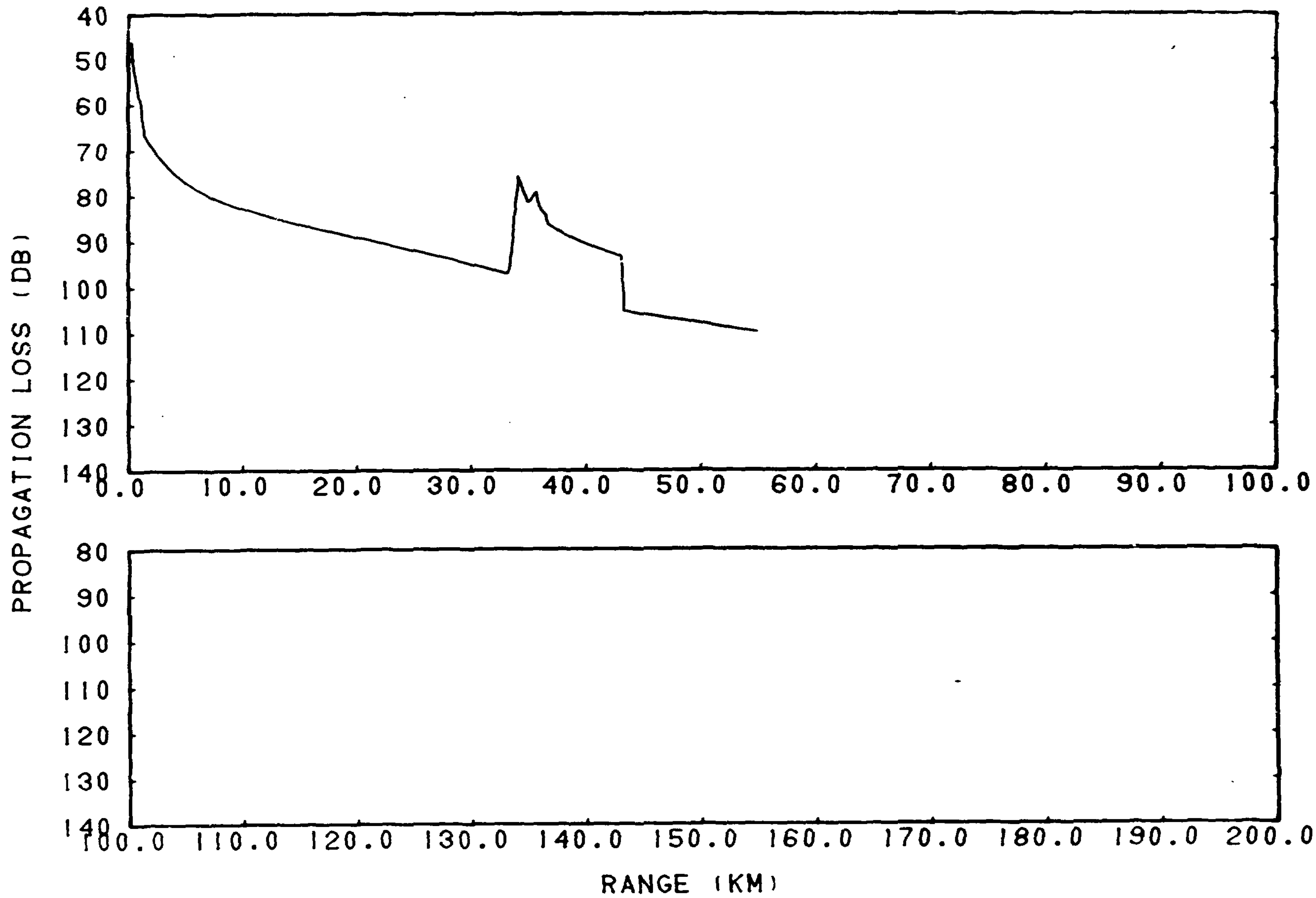
(C) Figure IIF-11g. Smoothed FACT Semi-coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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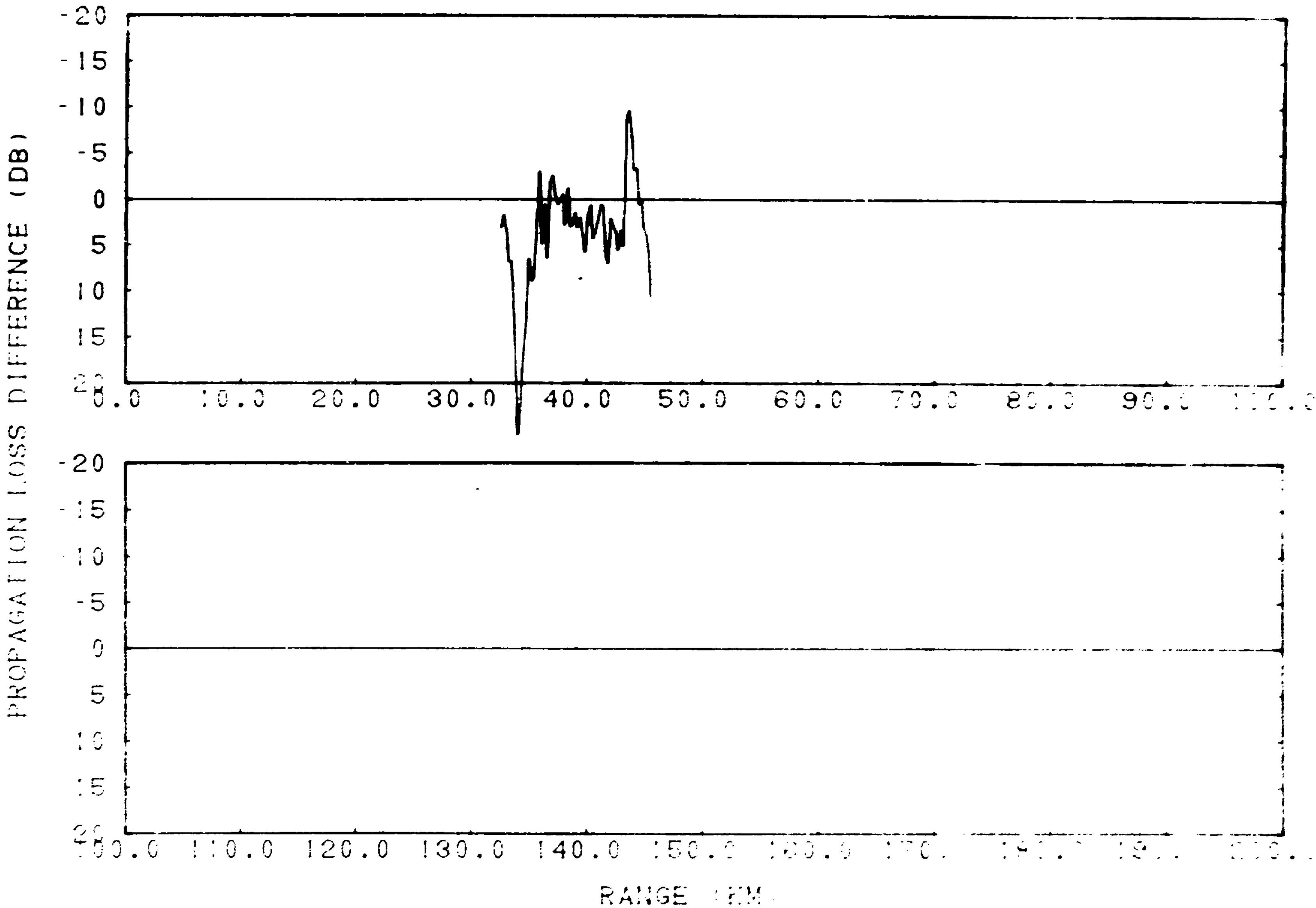
(C) Figure IIF-11h. FACT Incoherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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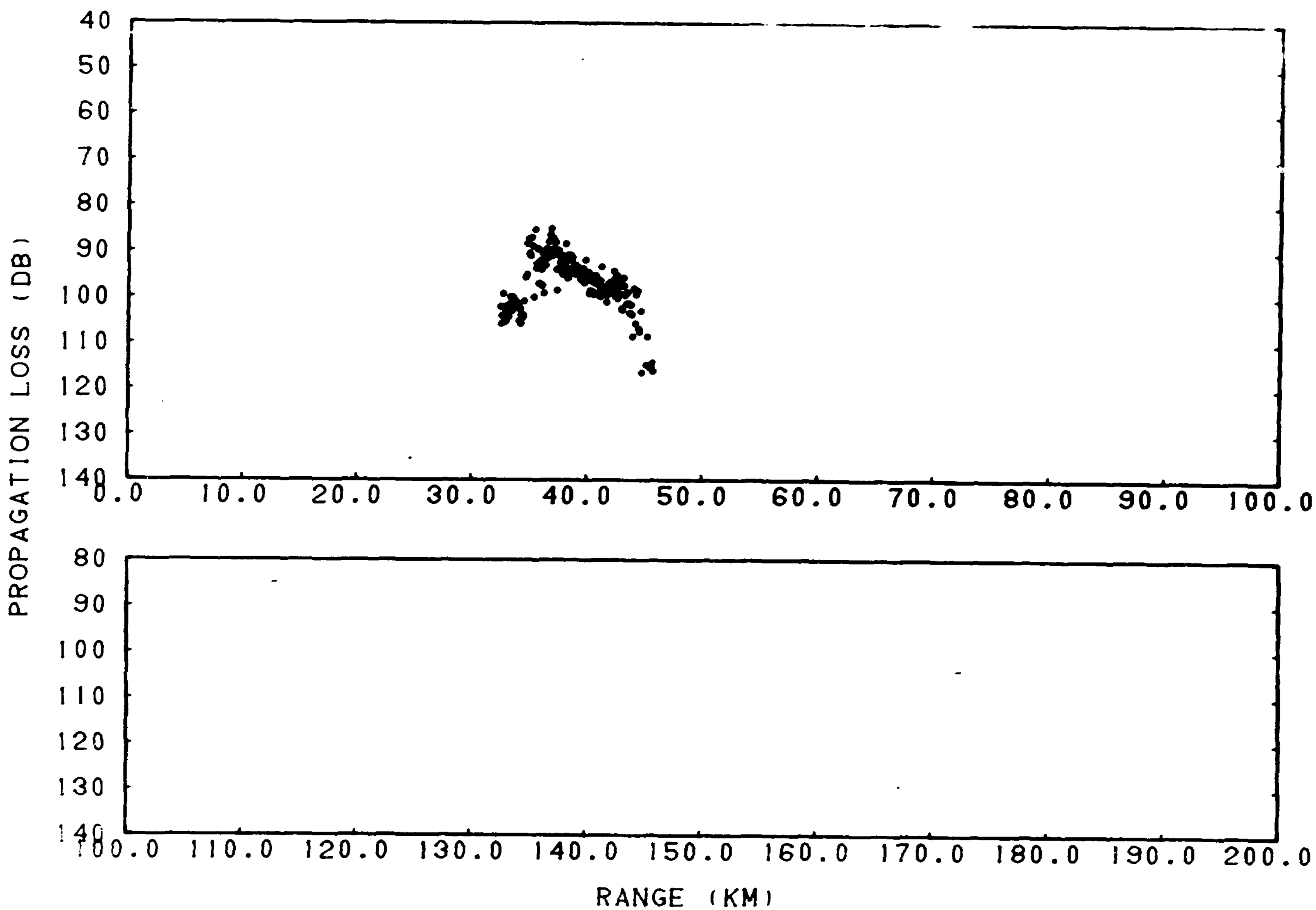
(C) Figure IIF-11i. FACT Incoherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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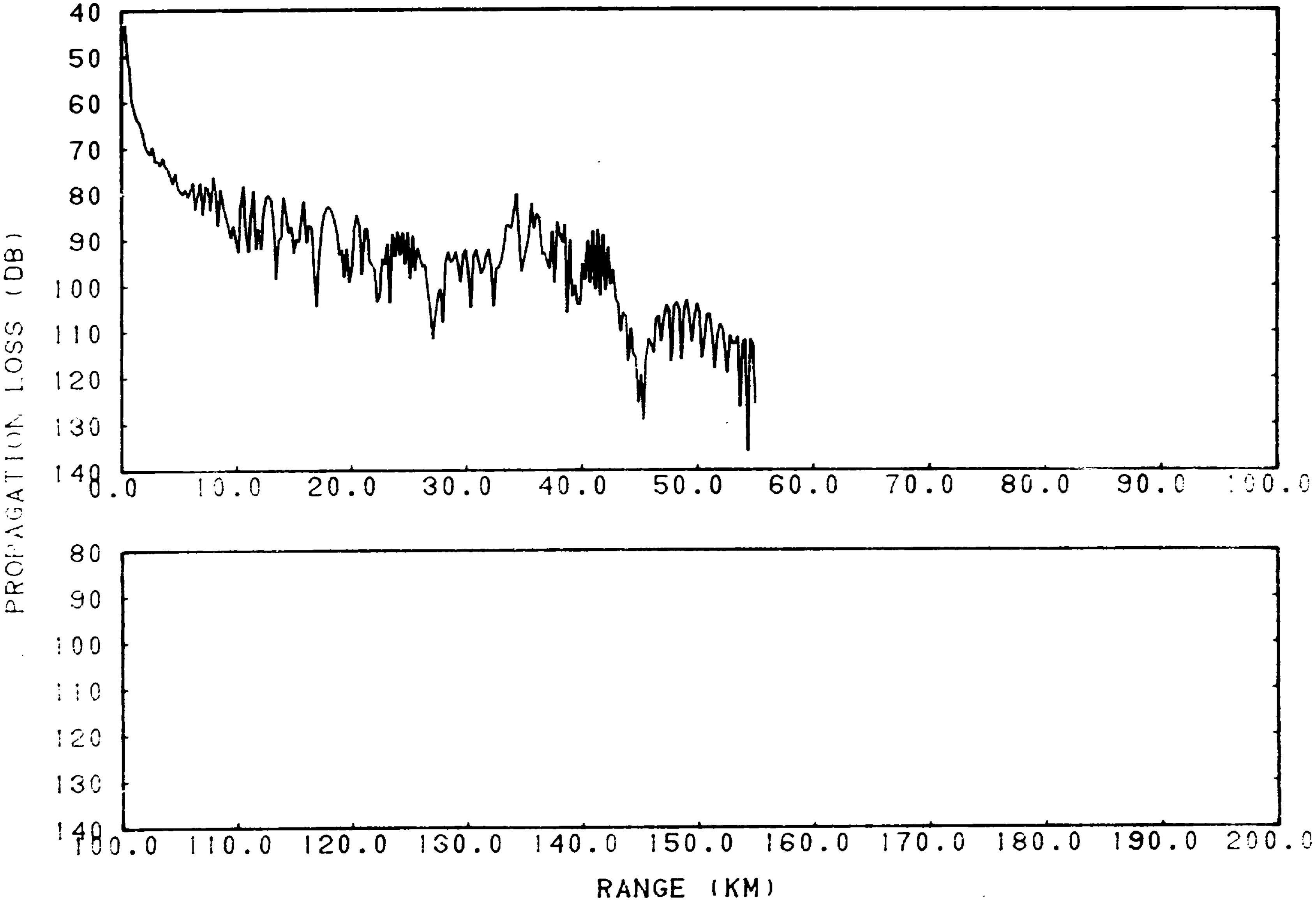
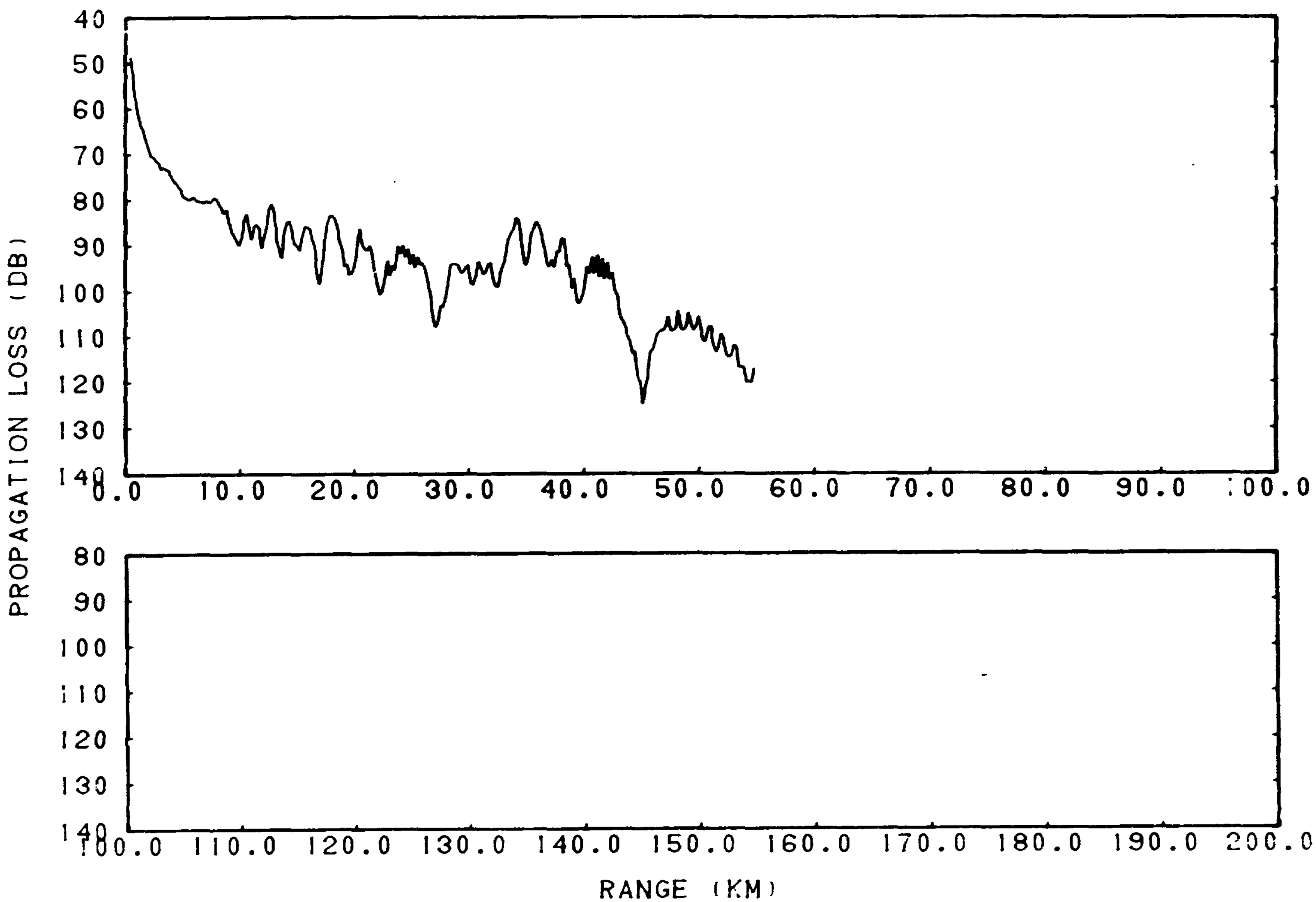
(C) Figure IIF-12a. Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 260 Feet



CONFIDENTIAL

(C) Figure IIF-12b. FACT Coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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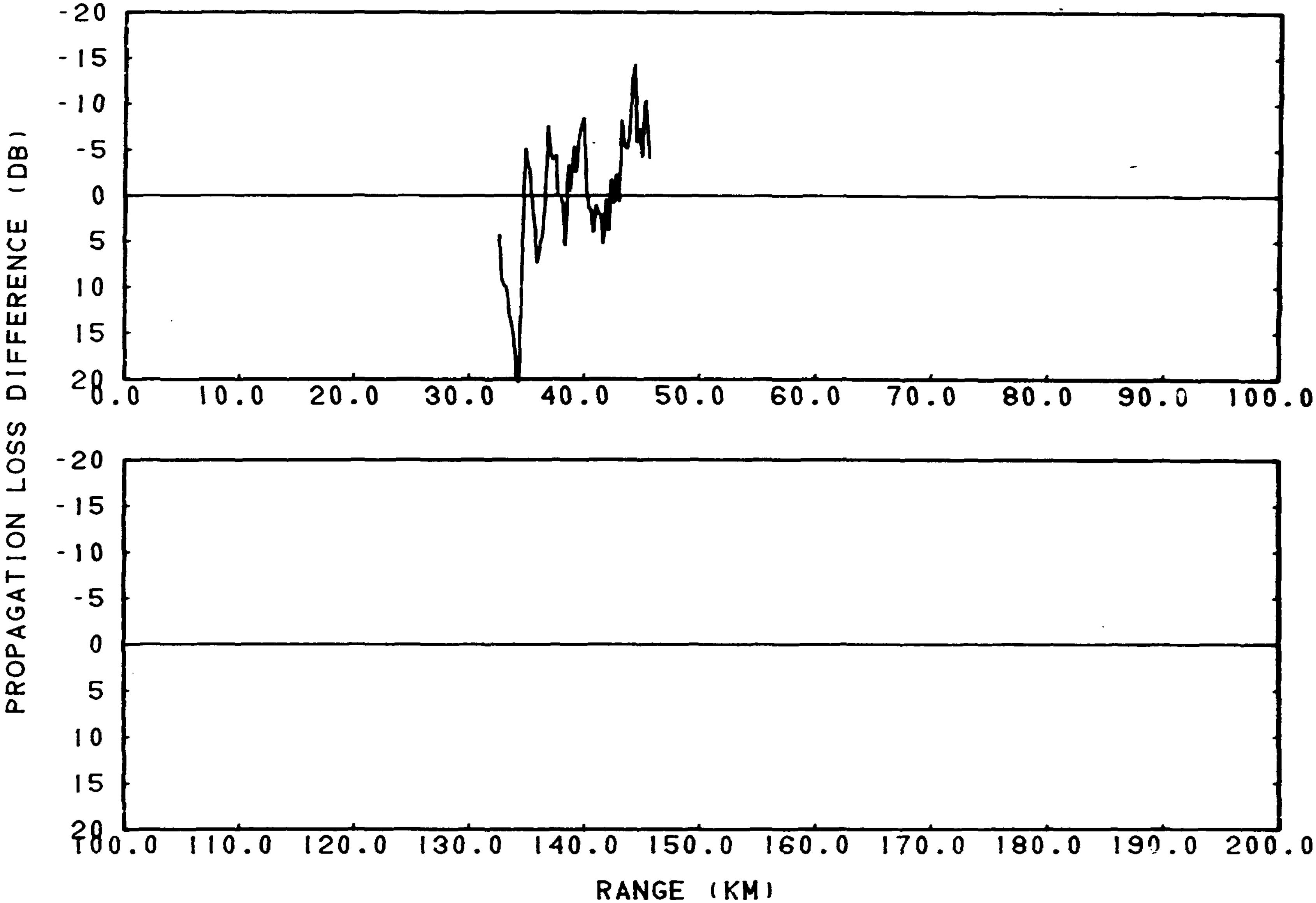
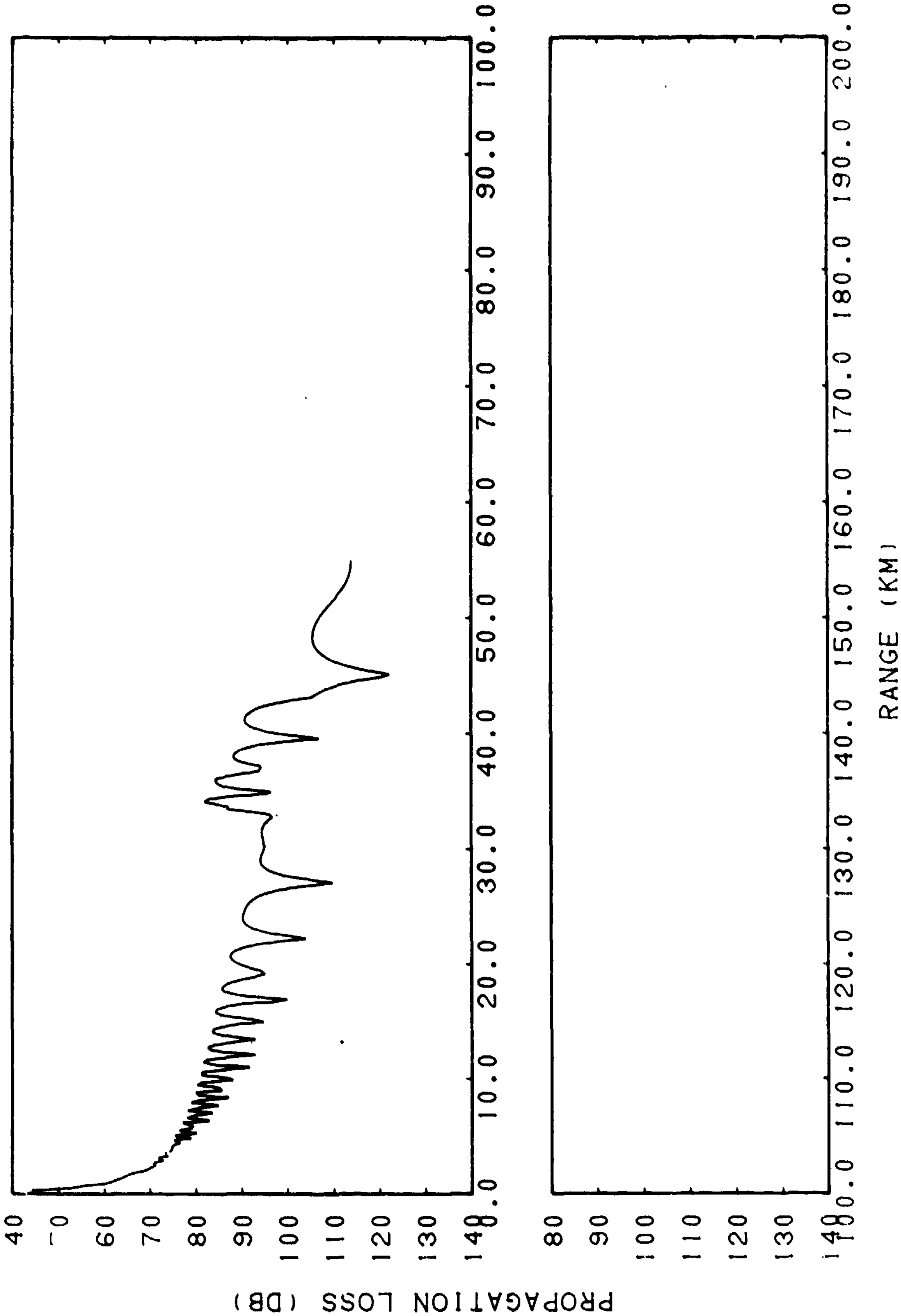
(C) Figure IIF-12c. FACT Coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



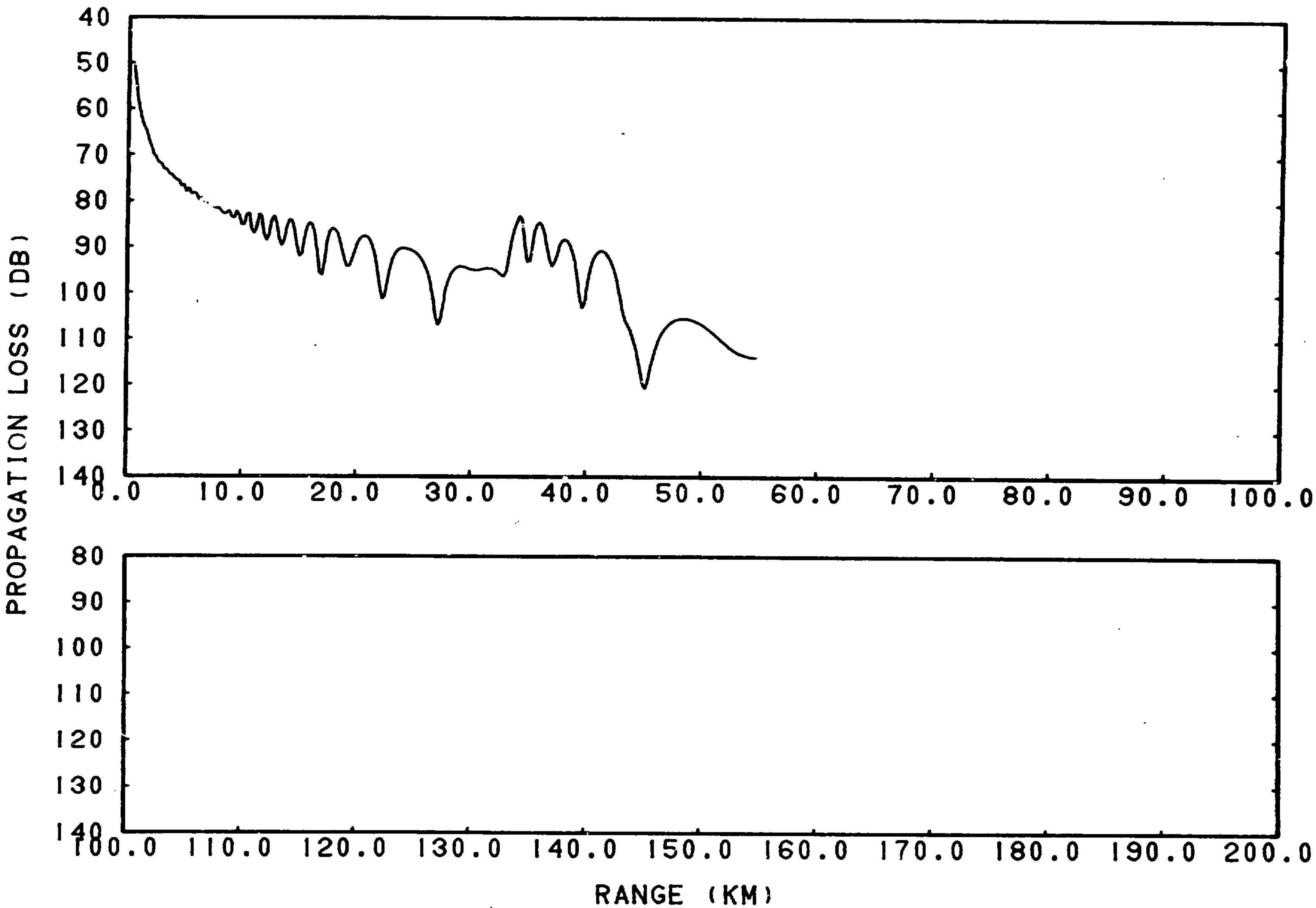
CONFIDENTIAL

(C) Figure IIF-12d. Smoothed FACT Coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Subtracted from Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 260 Feet



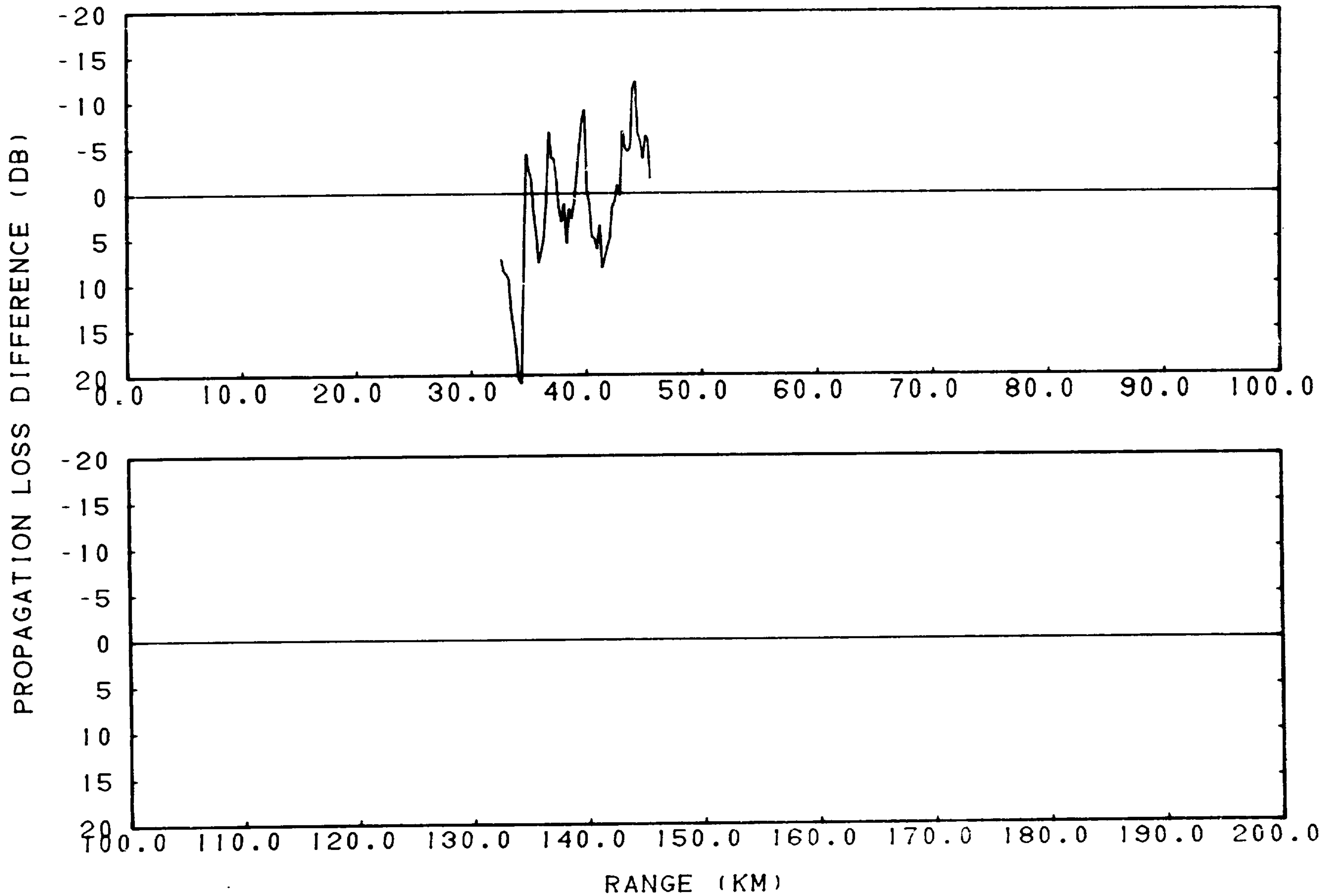
CONFIDENTIAL

(C) Figure IIF-12e. FACT Semi-coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 260 Feet



CONFIDENTIAL

(C) Figure IIF-12f. FACT Semi-coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



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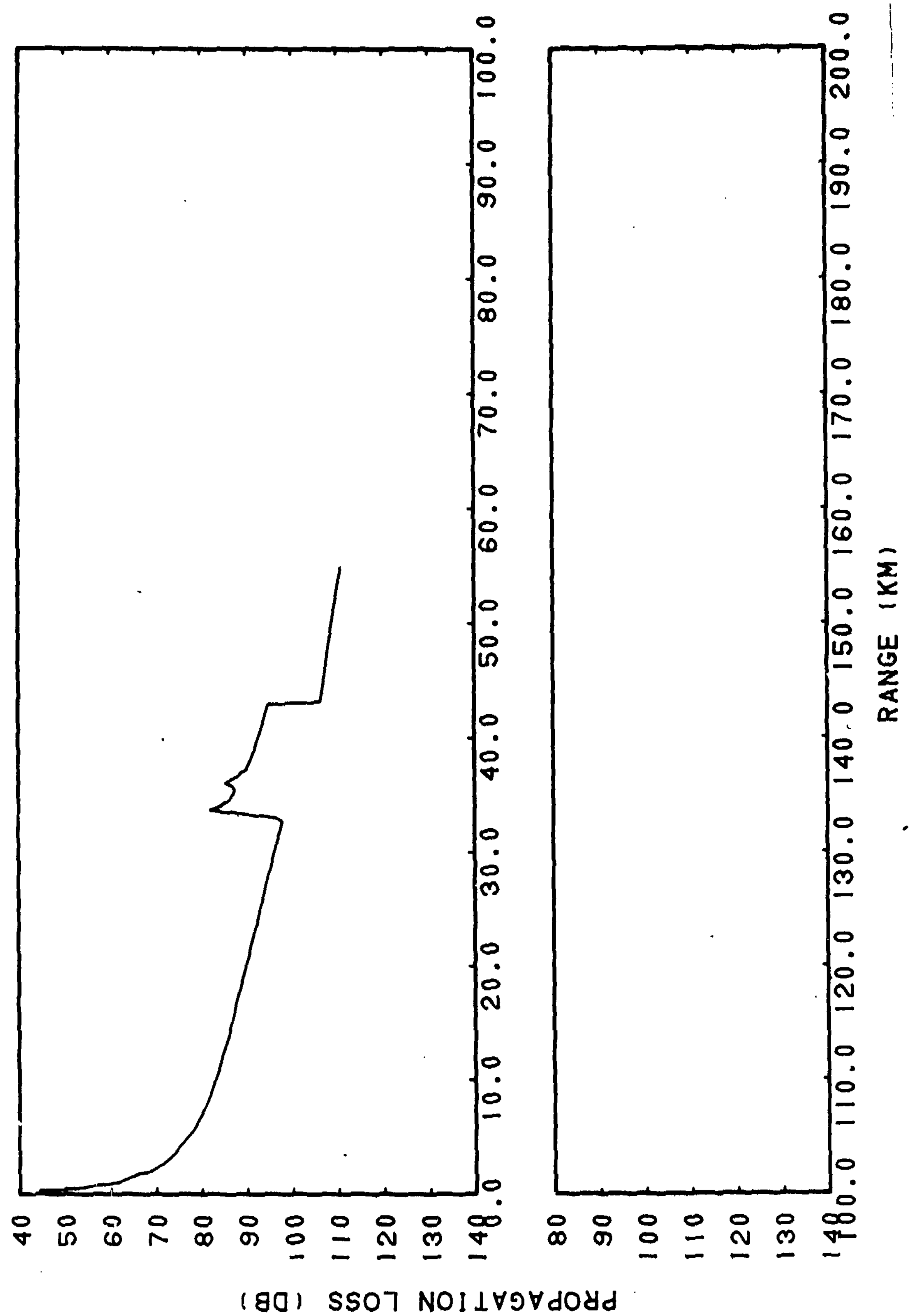
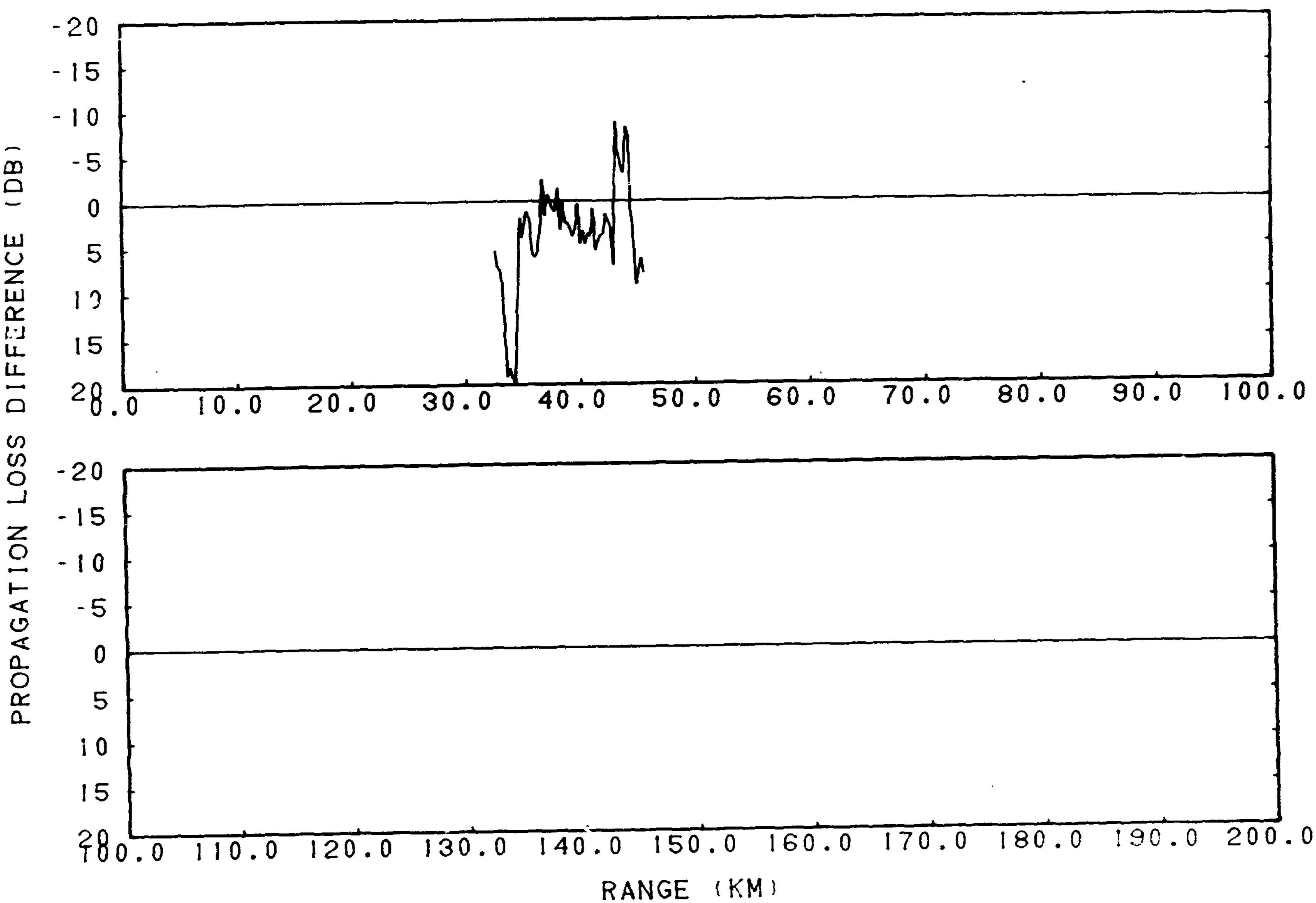
(C) Figure IIF-12g. Smoothed FACT Semi-coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Subtracted from Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 260 Feet



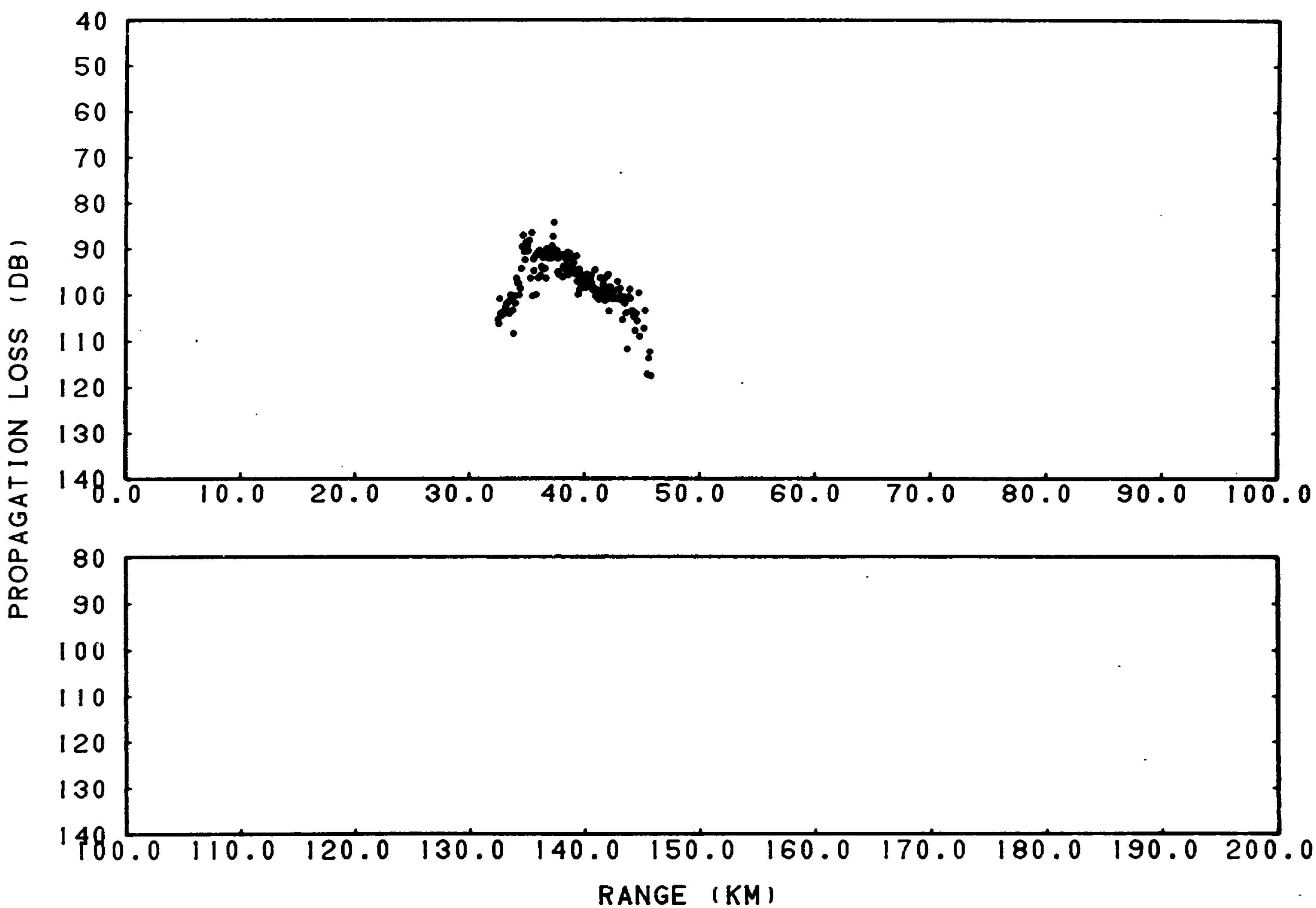
CONFIDENTIAL

(C) Figure IIF-12h. FACT Incoherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 260 Feet



CONFIDENTIAL

(C) *Figure* IIF-12i. FACT Incoherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Subtracted from Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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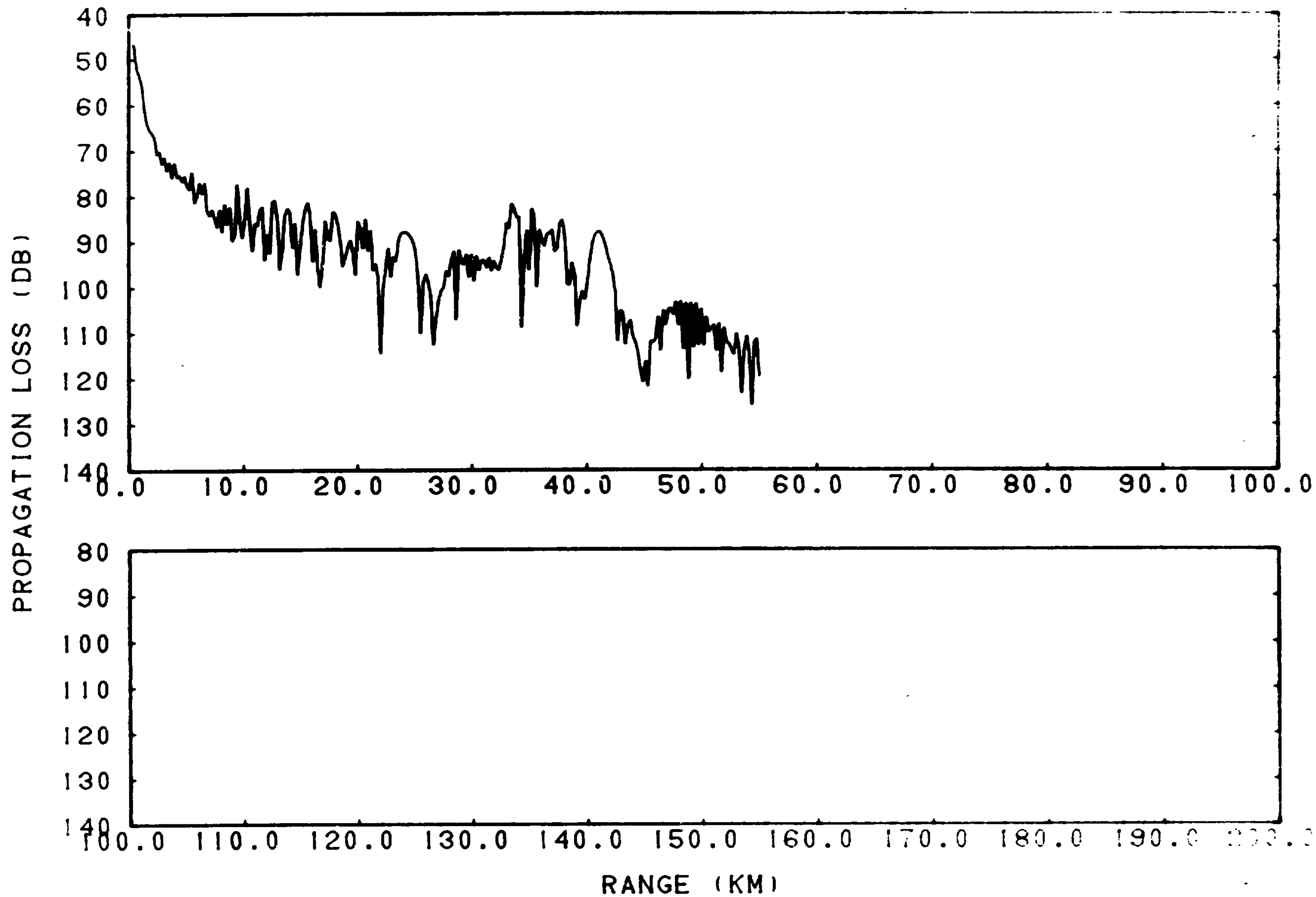
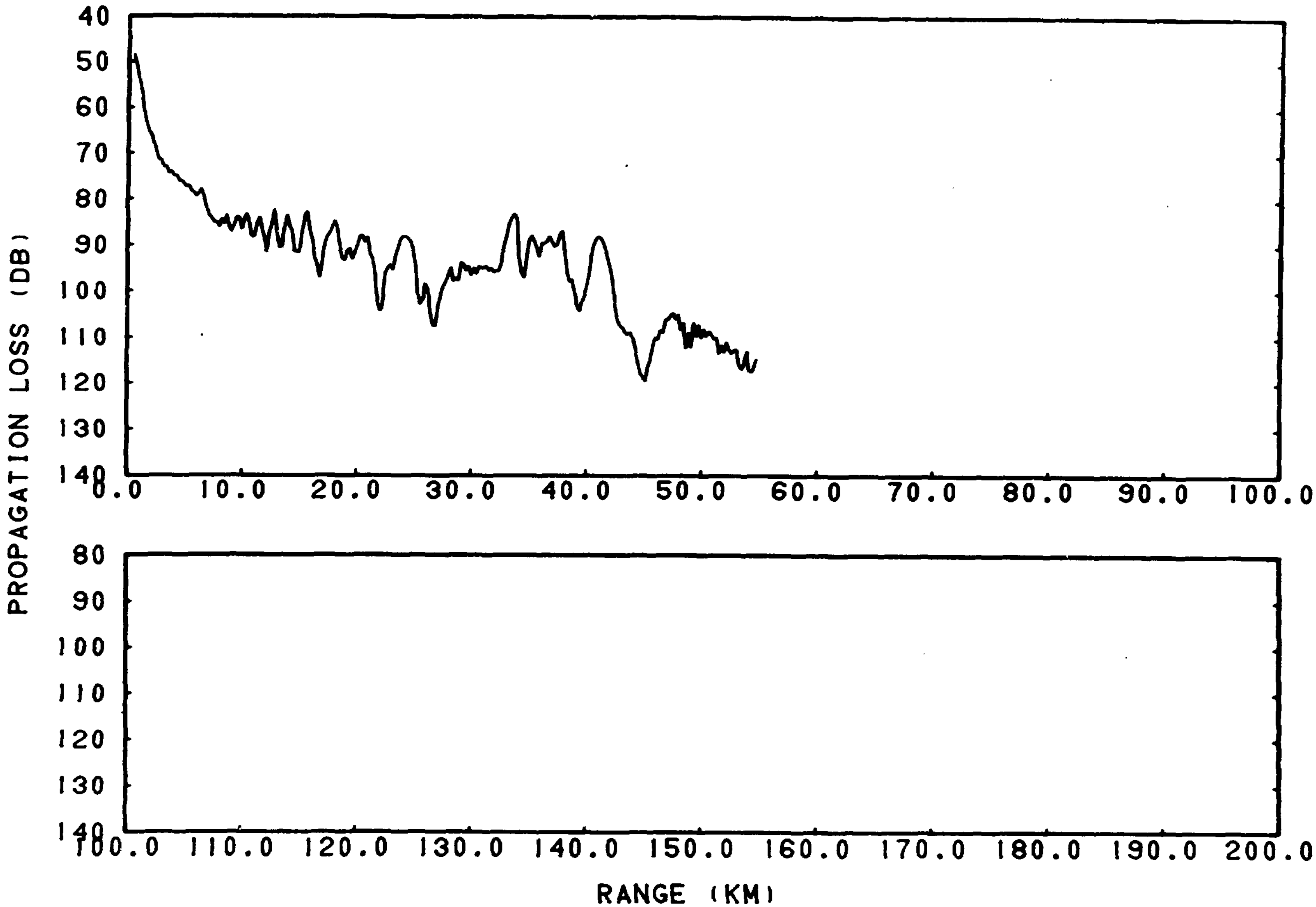
(C) Figure IIF-13a. Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 535 Feet



CONFIDENTIAL

(C) Figure IIF-13b. FACT Coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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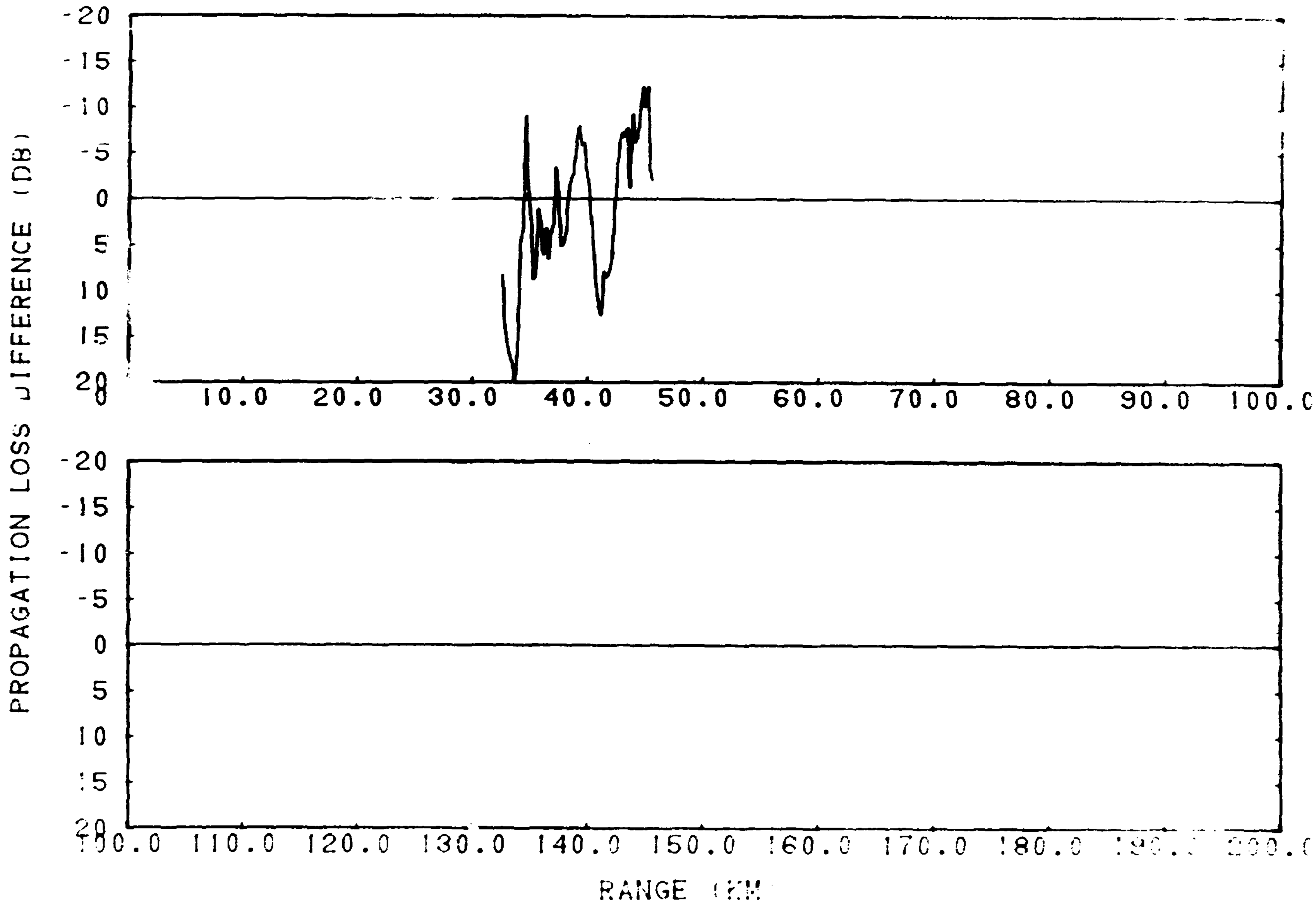
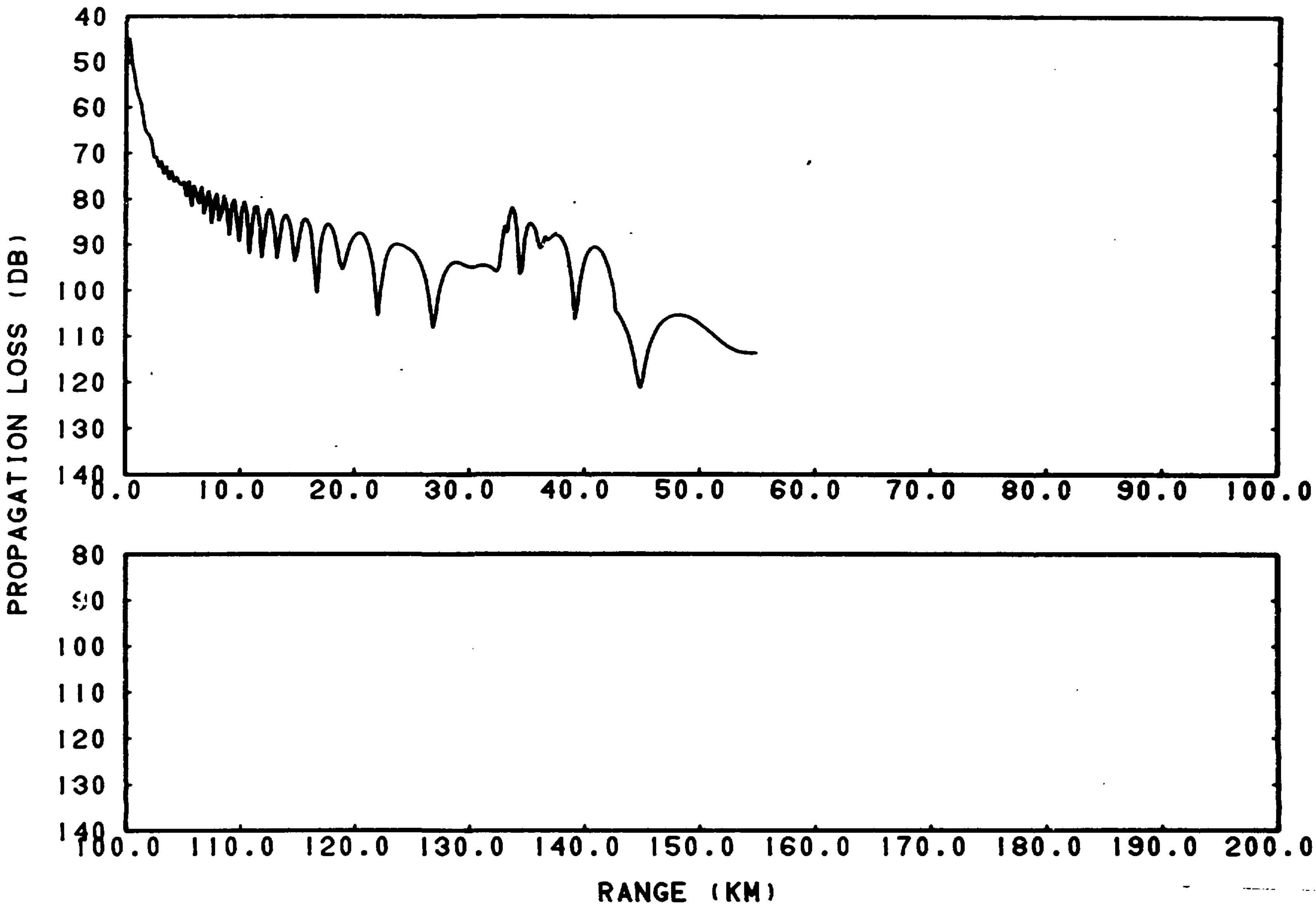
(C) Figure IIF-13c. FACT Coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



CONFIDENTIAL

(C) Figure IIF-13d. Smoothed FACT Coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Subtracted from Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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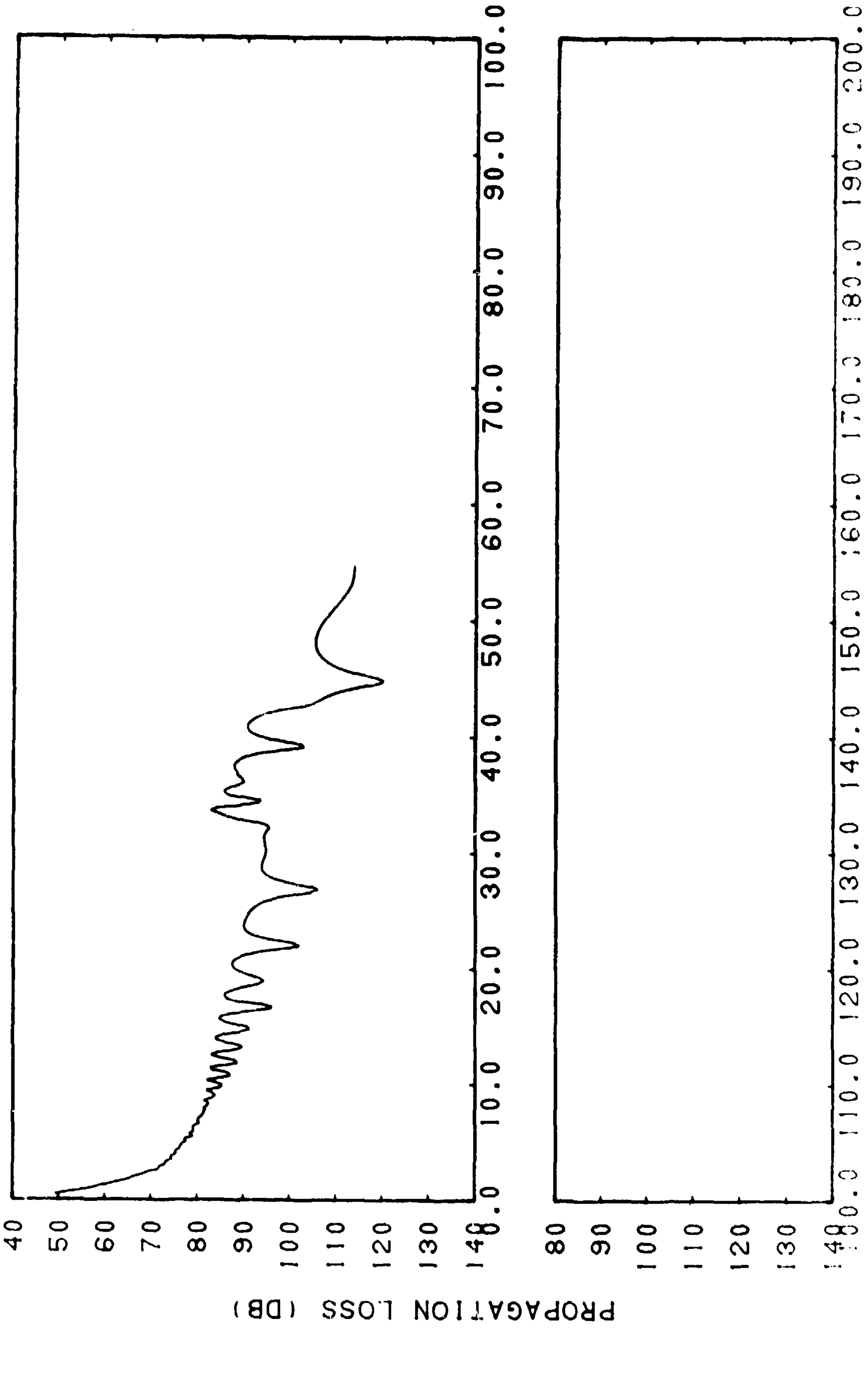
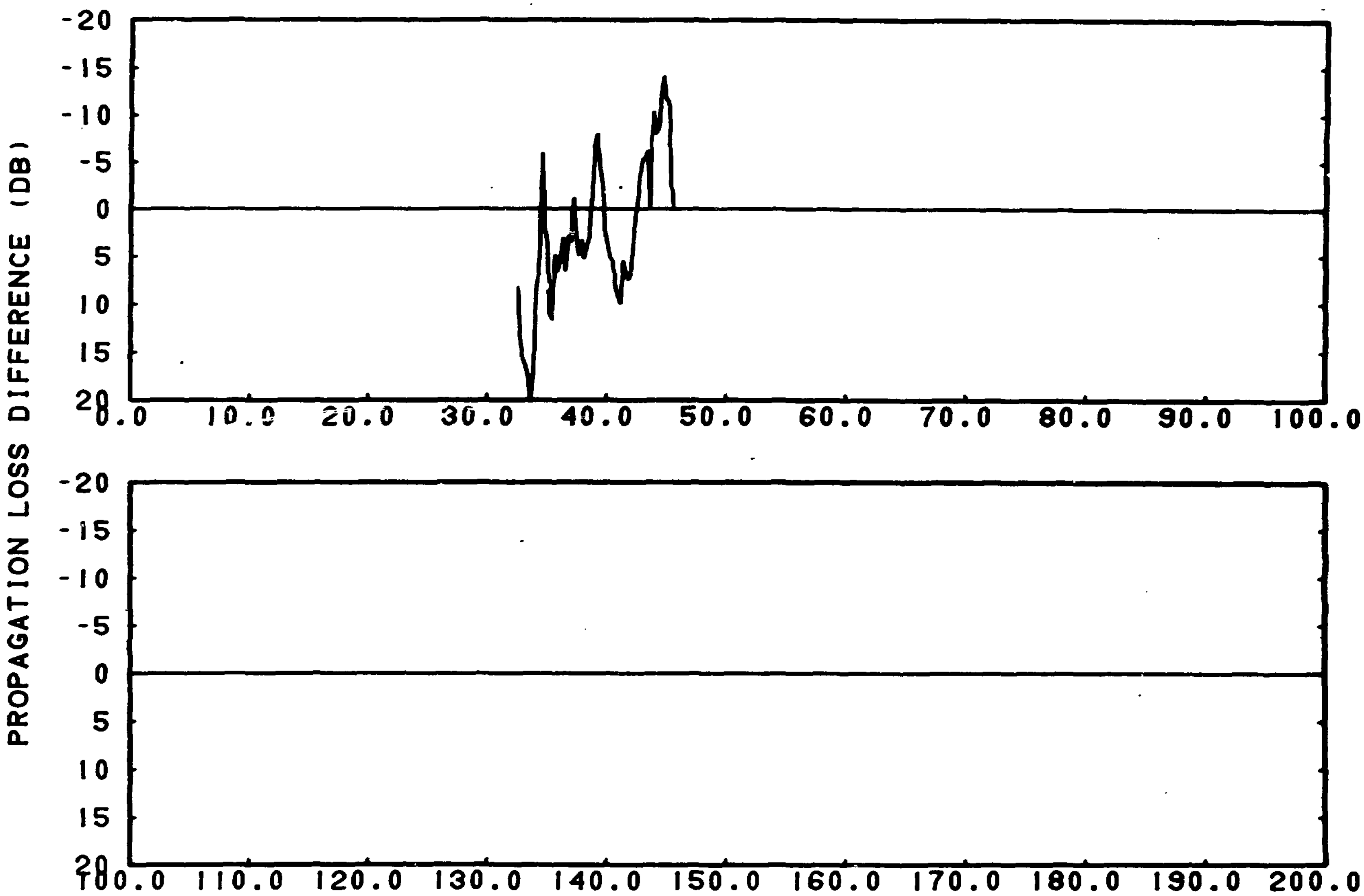
(C) Figure IIF-13e. FACT Semi-coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 535 Feet



(C) Figure IIF-13f. FACT Semi-coherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



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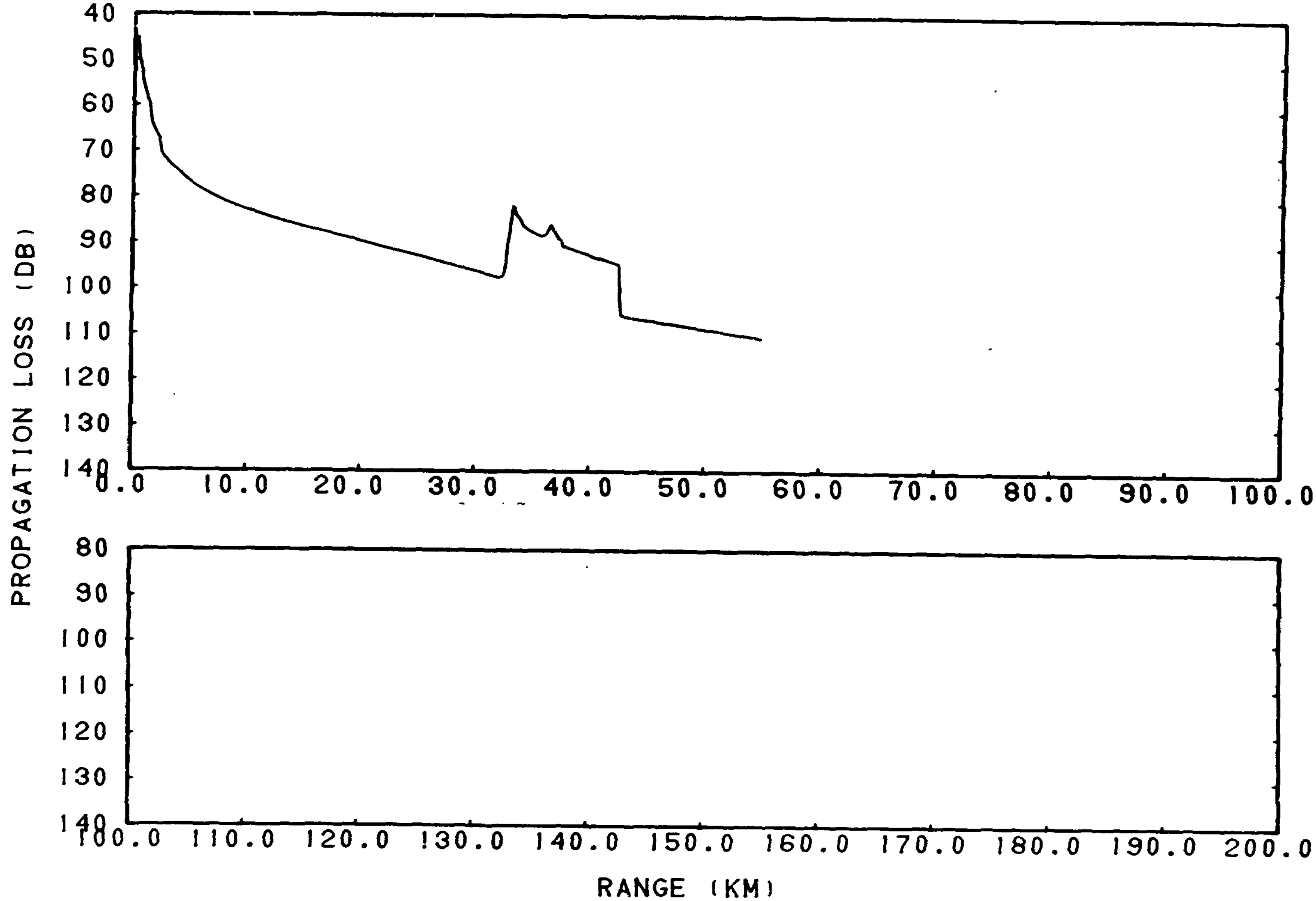
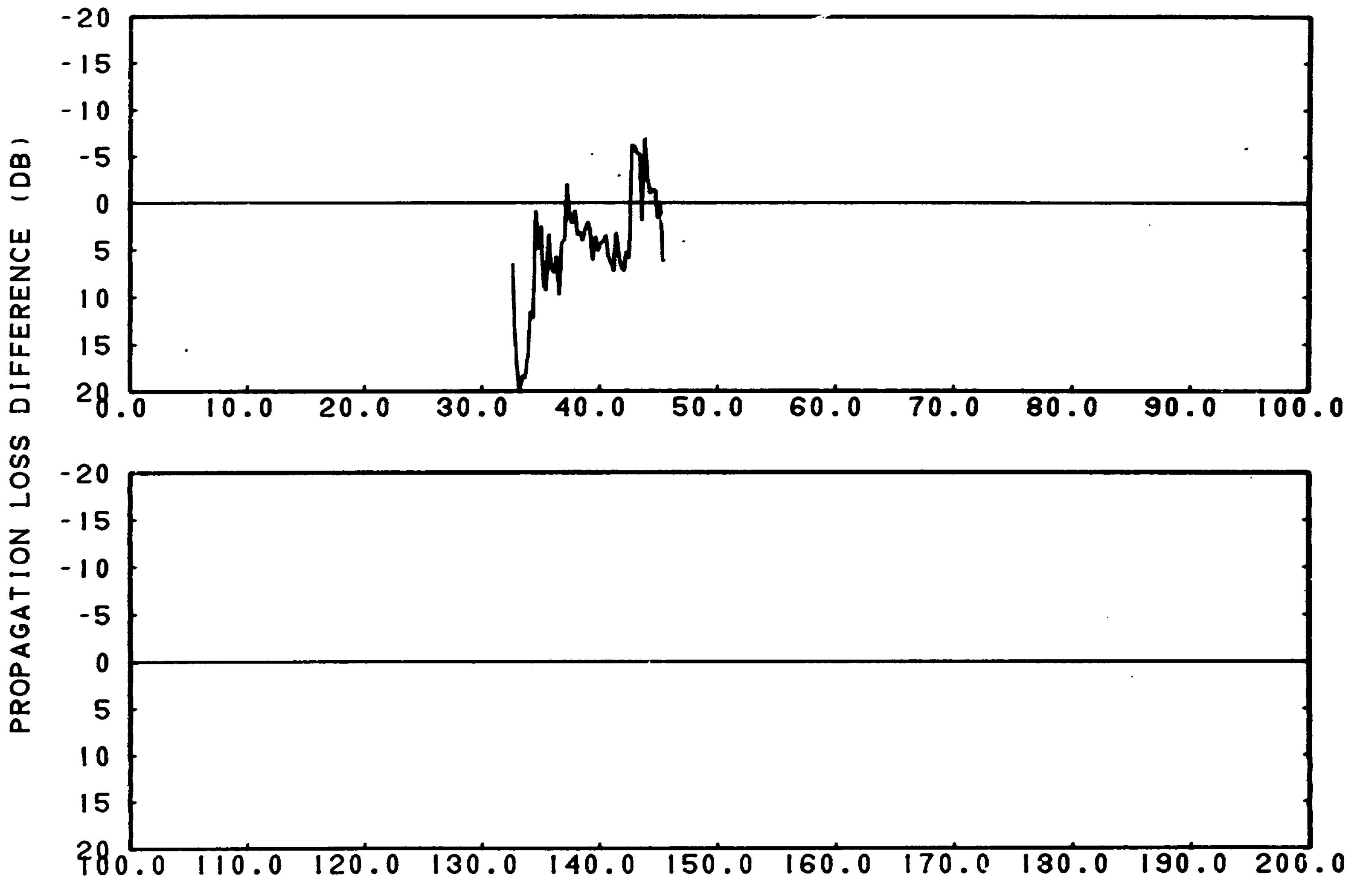
(C) Figure IIF-13g. Smoothed *FACT Semi-coherent Station* 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Subtracted from Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 535 Feet



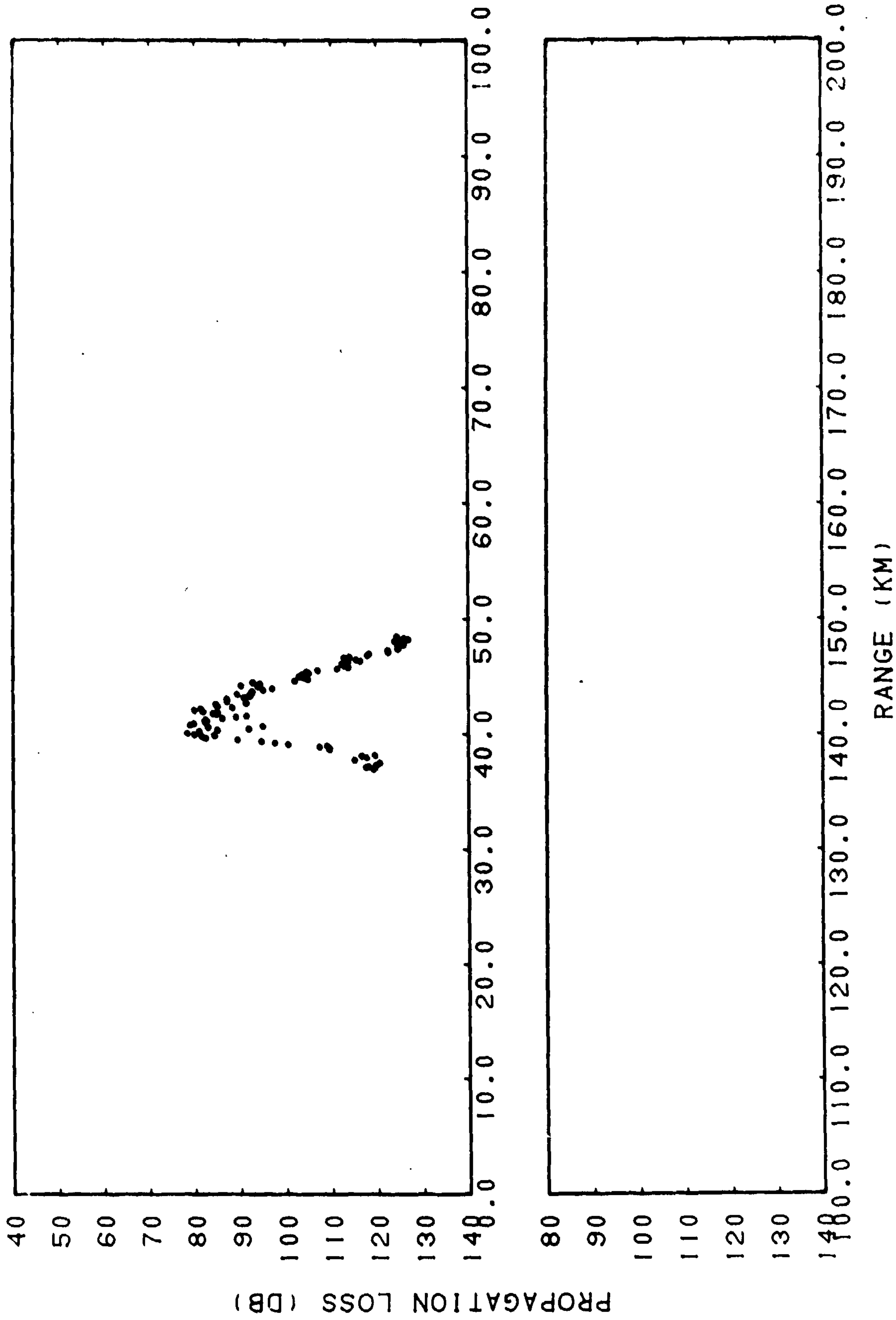
CONFIDENTIAL

(C) Figure IIF-13h. FACT Incoherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 535 Feet



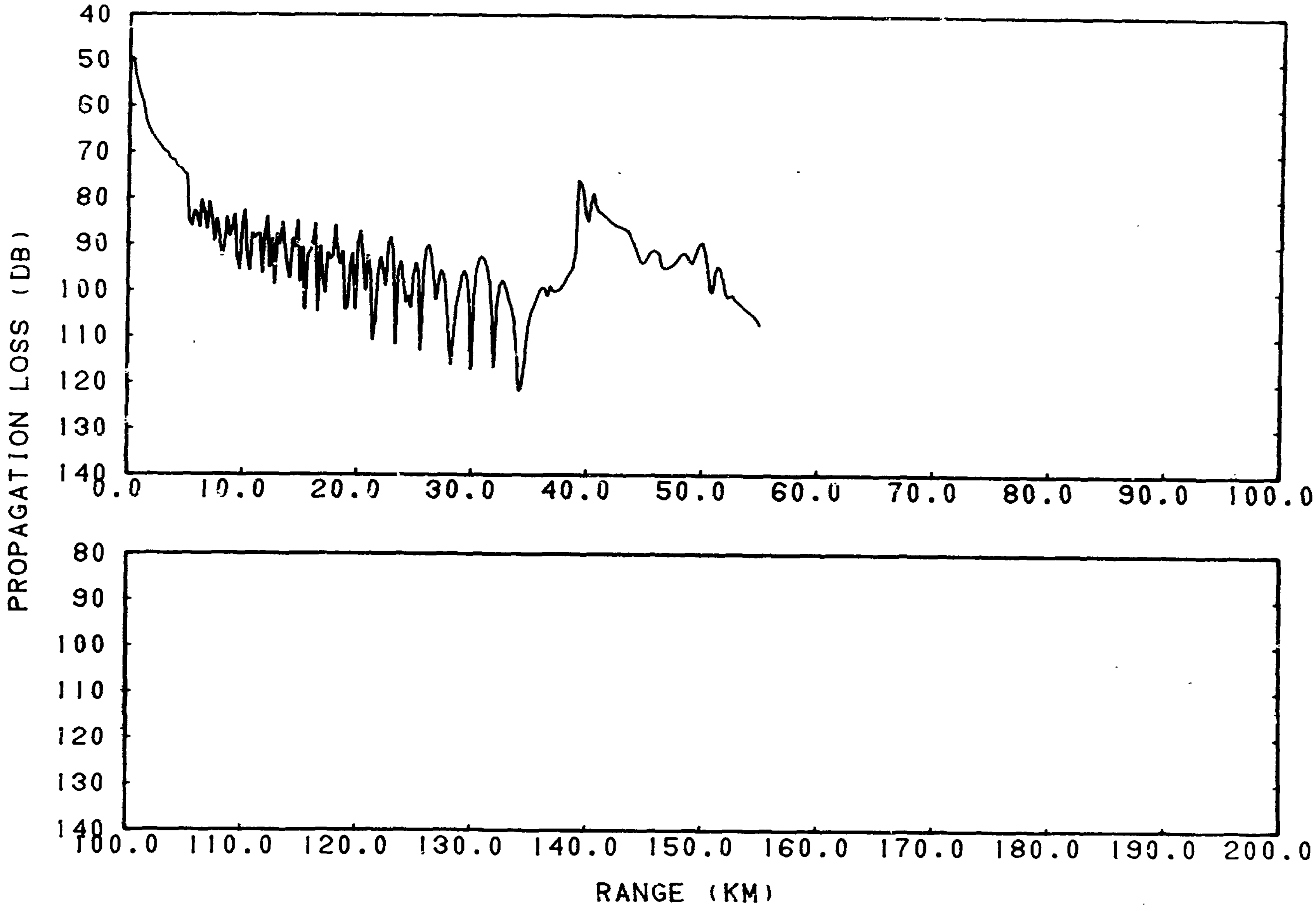
CONFIDENTIAL

(C) Figure IIF-13i. FACT Incoherent Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Subtracted from Station 2 Run 63, Source Depth = 20 Feet, Receiver Depth = 535 Feet



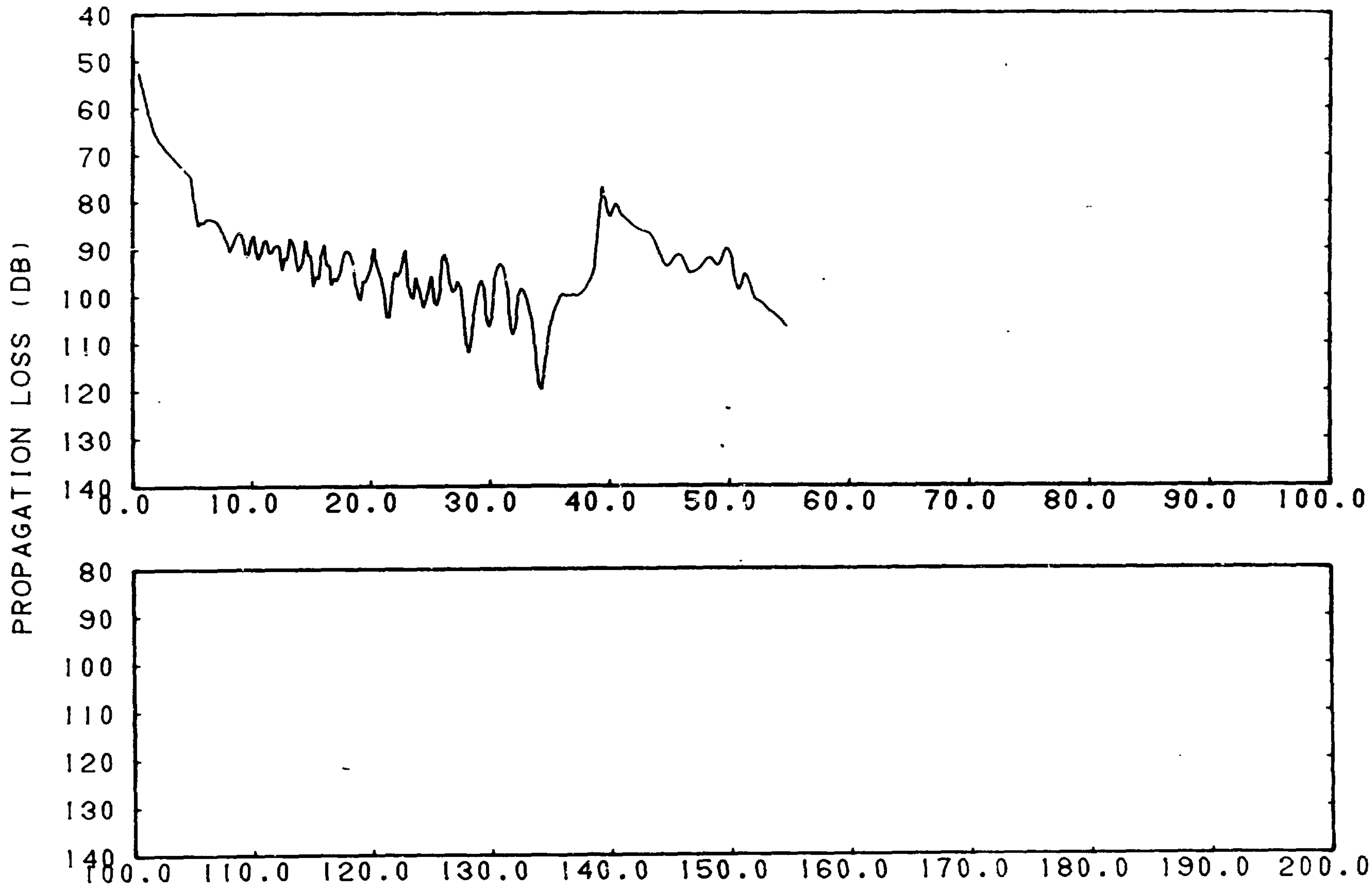
CONFIDENTIAL

(C) Figure IIF-14a. Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



CONFIDENTIAL

(C) Figure IIF-14b. FACT Coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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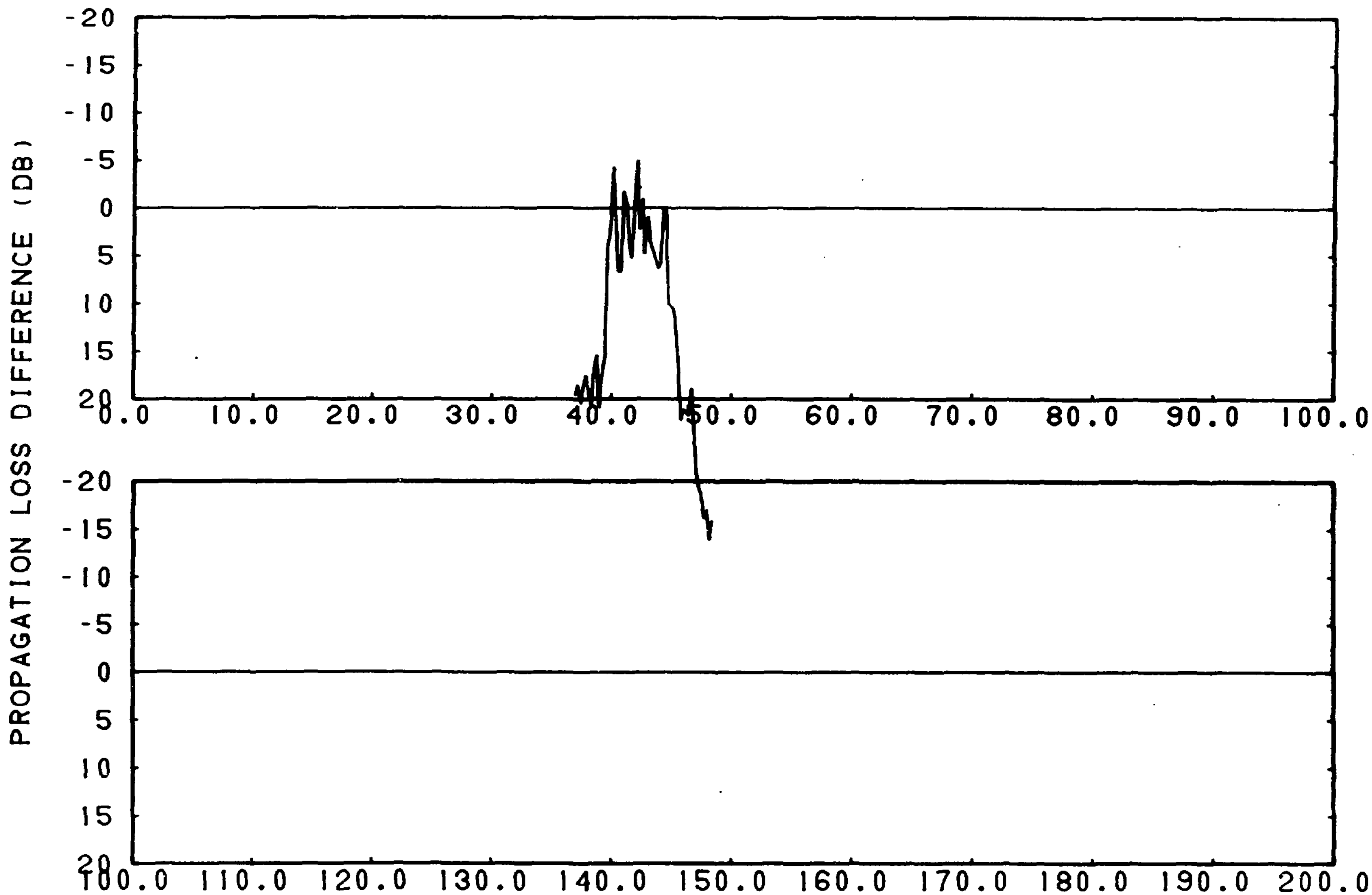
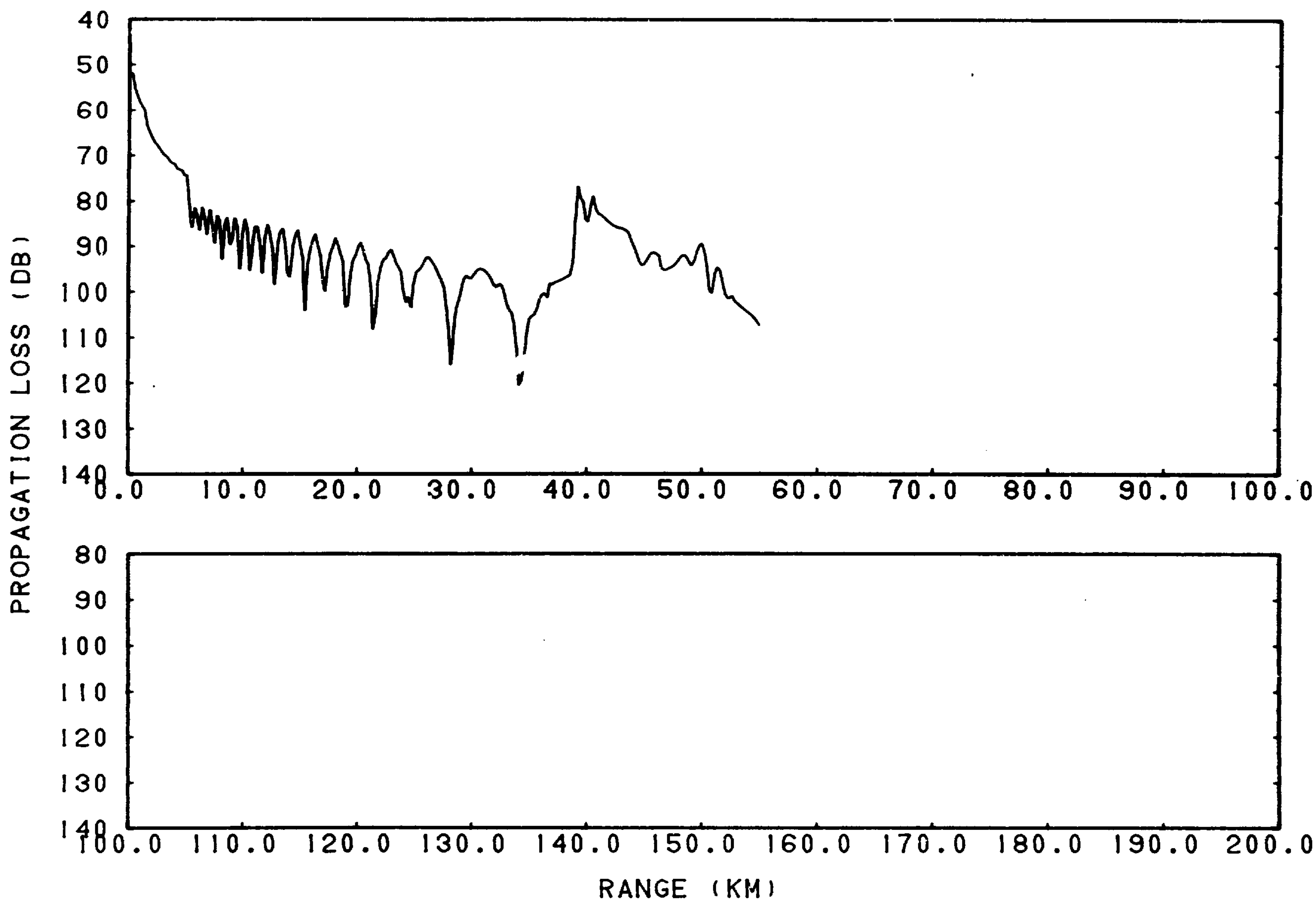
(C) Figure IIF-14c. FACT Coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



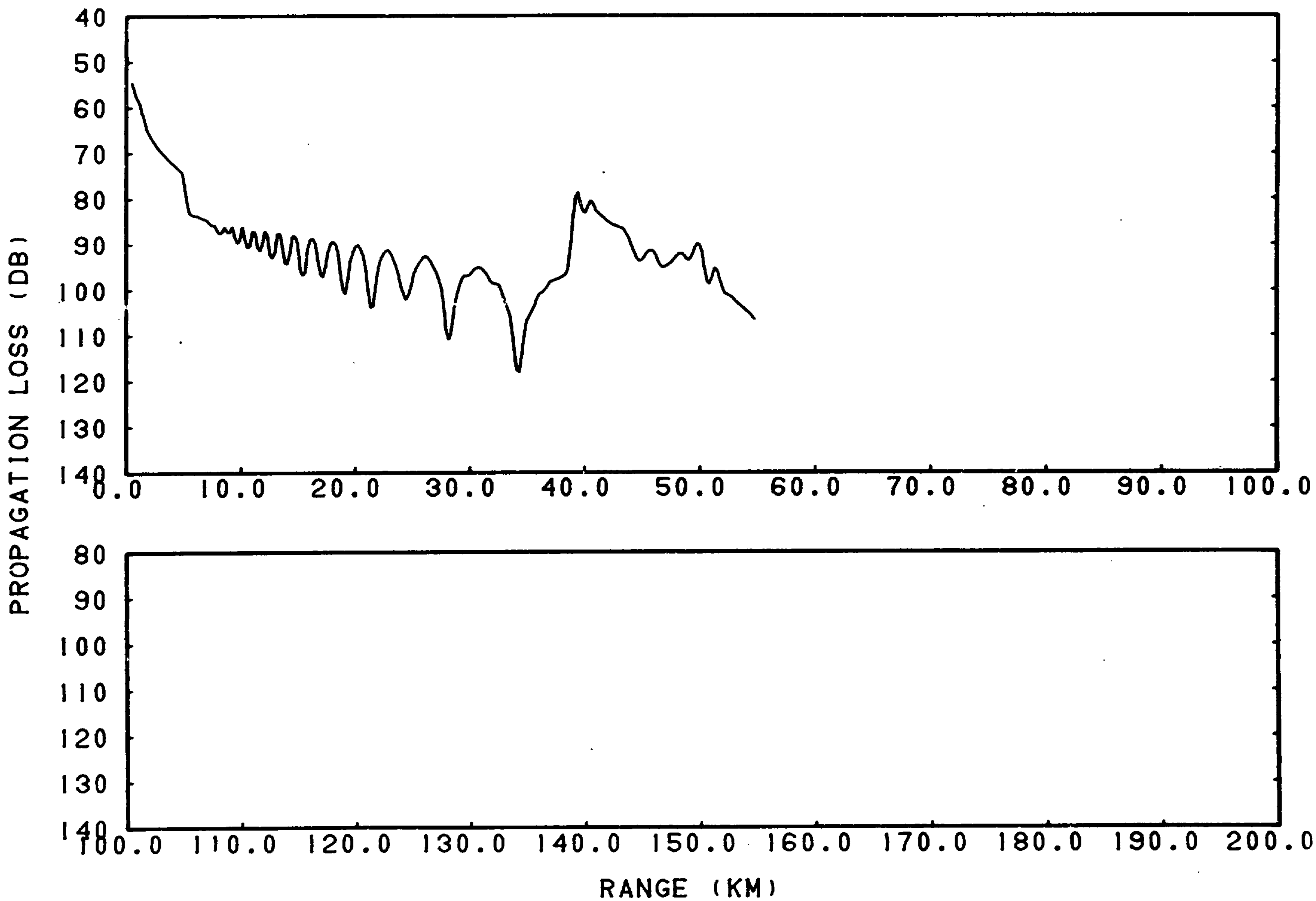
CONFIDENTIAL

(C) Figure IIF-14d. Smoothed FACT Coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



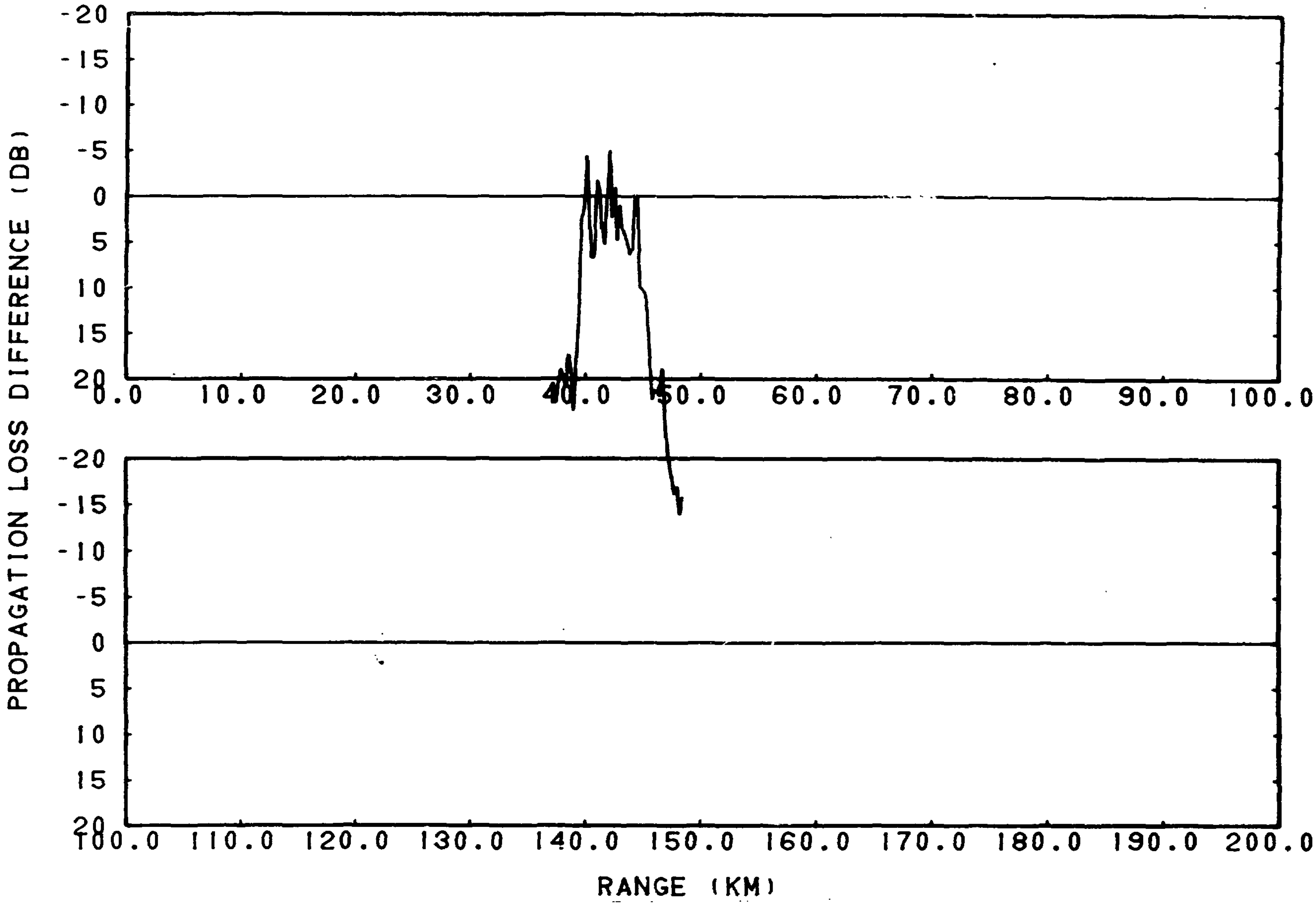
CONFIDENTIAL

(C) Figure IIF-14e. FACT Semi-coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



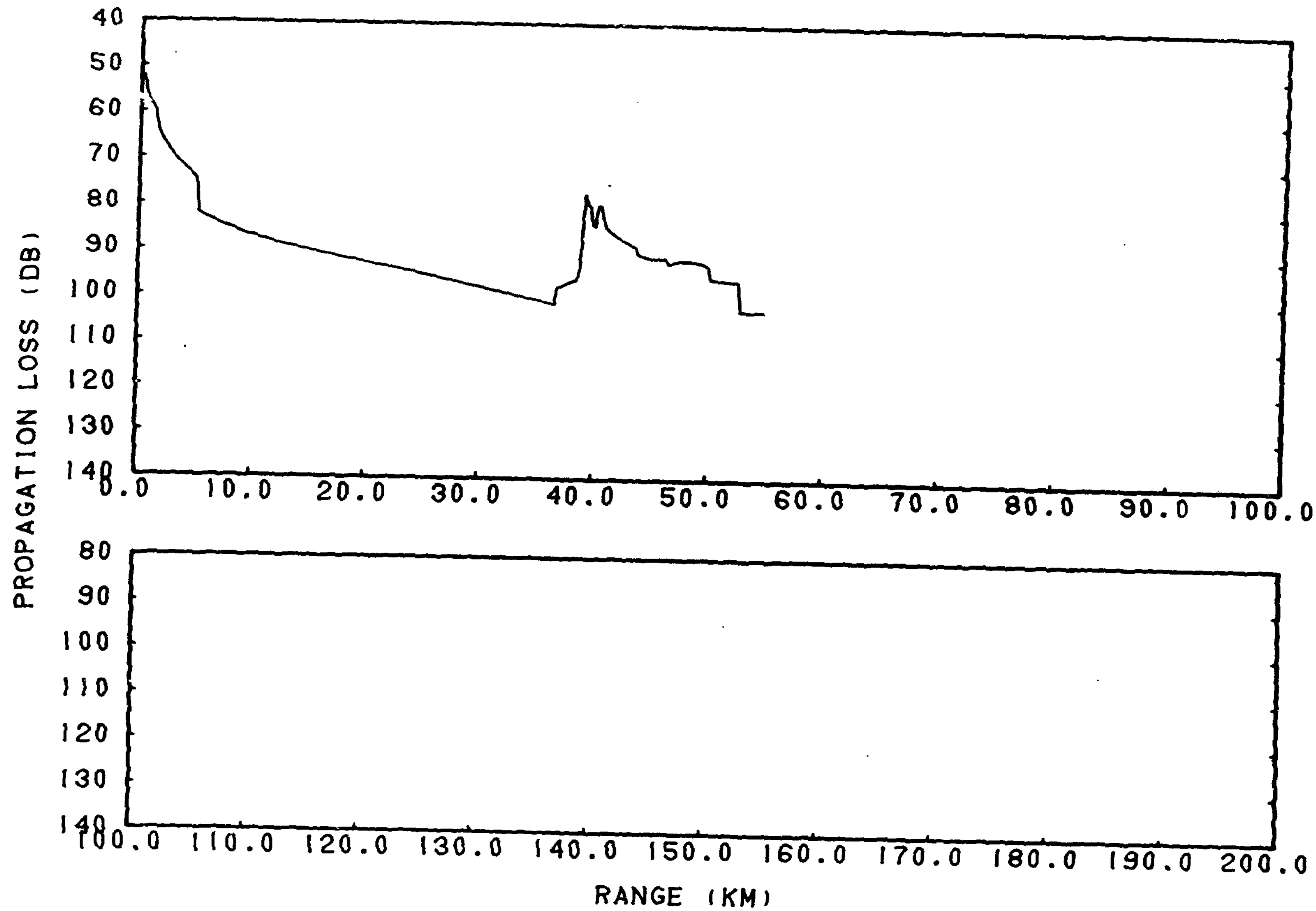
CONFIDENTIAL

(C) Figure IIF-14f. FACT Semi-coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



CONFIDENTIAL

(C) Figure IIF-14g. Smoothed FACT Semi-coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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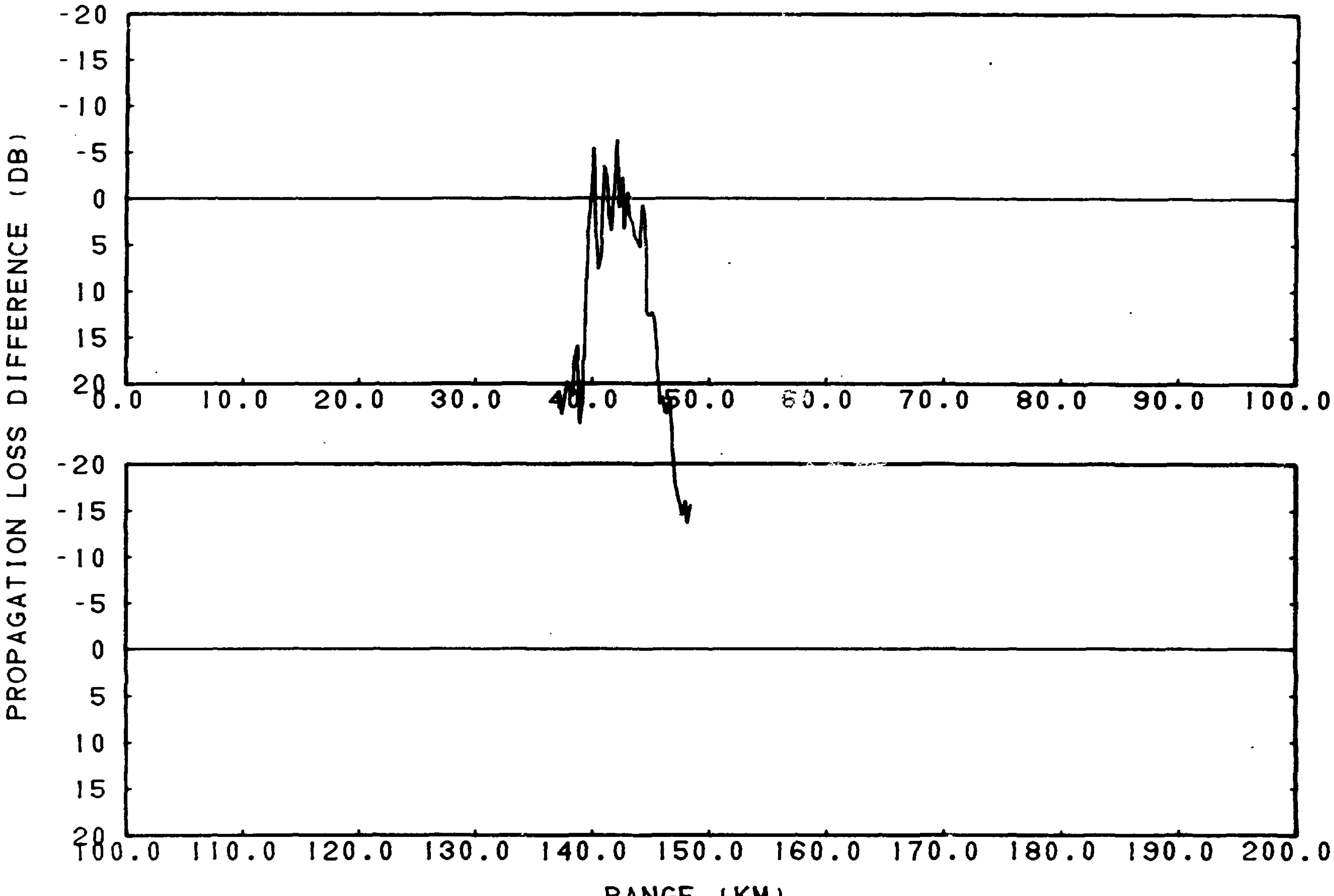
(C) Figure IIF-14h. FACT *Incoherent Station* 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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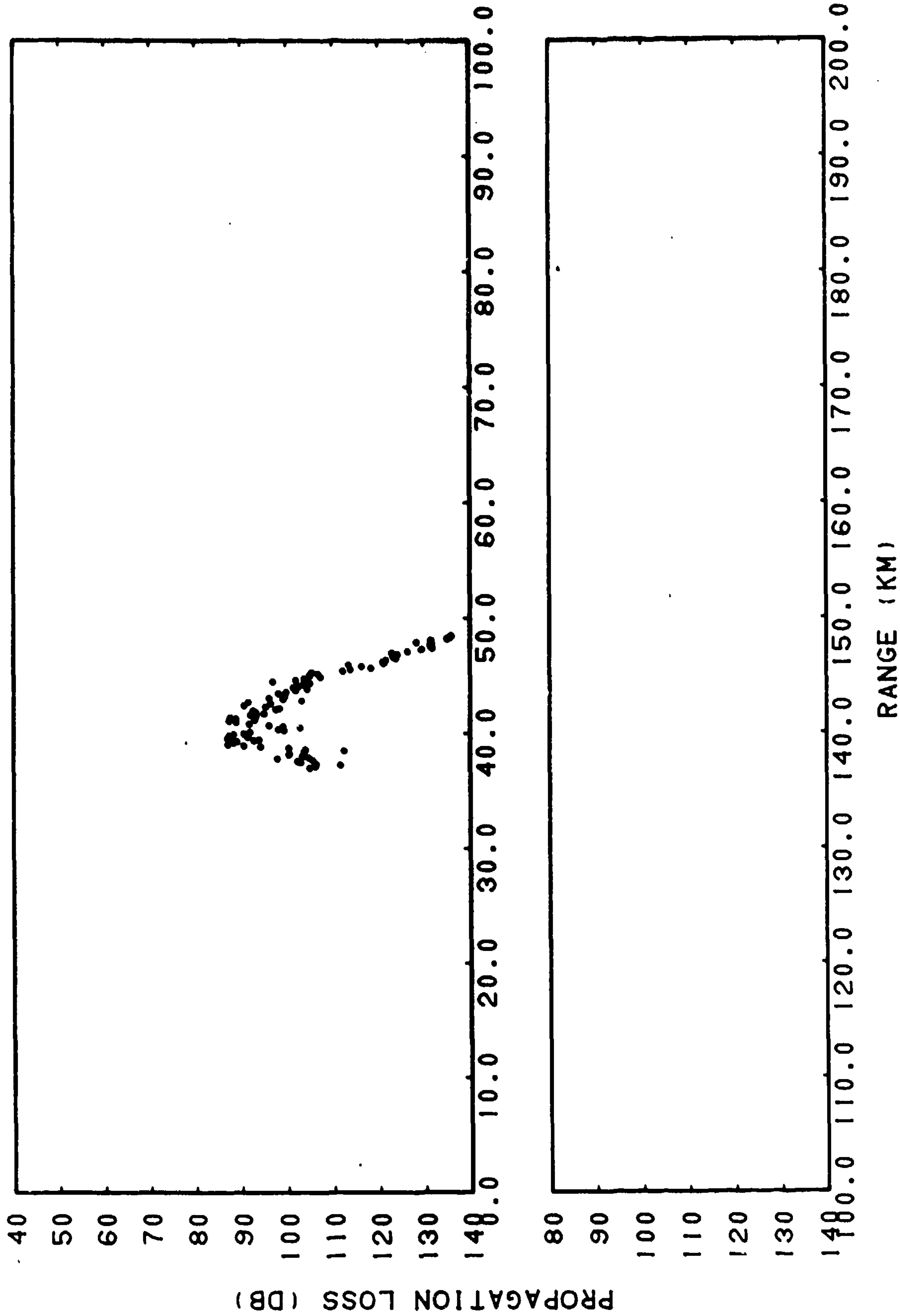
(C) Figure IIF-14i. FACT Incoherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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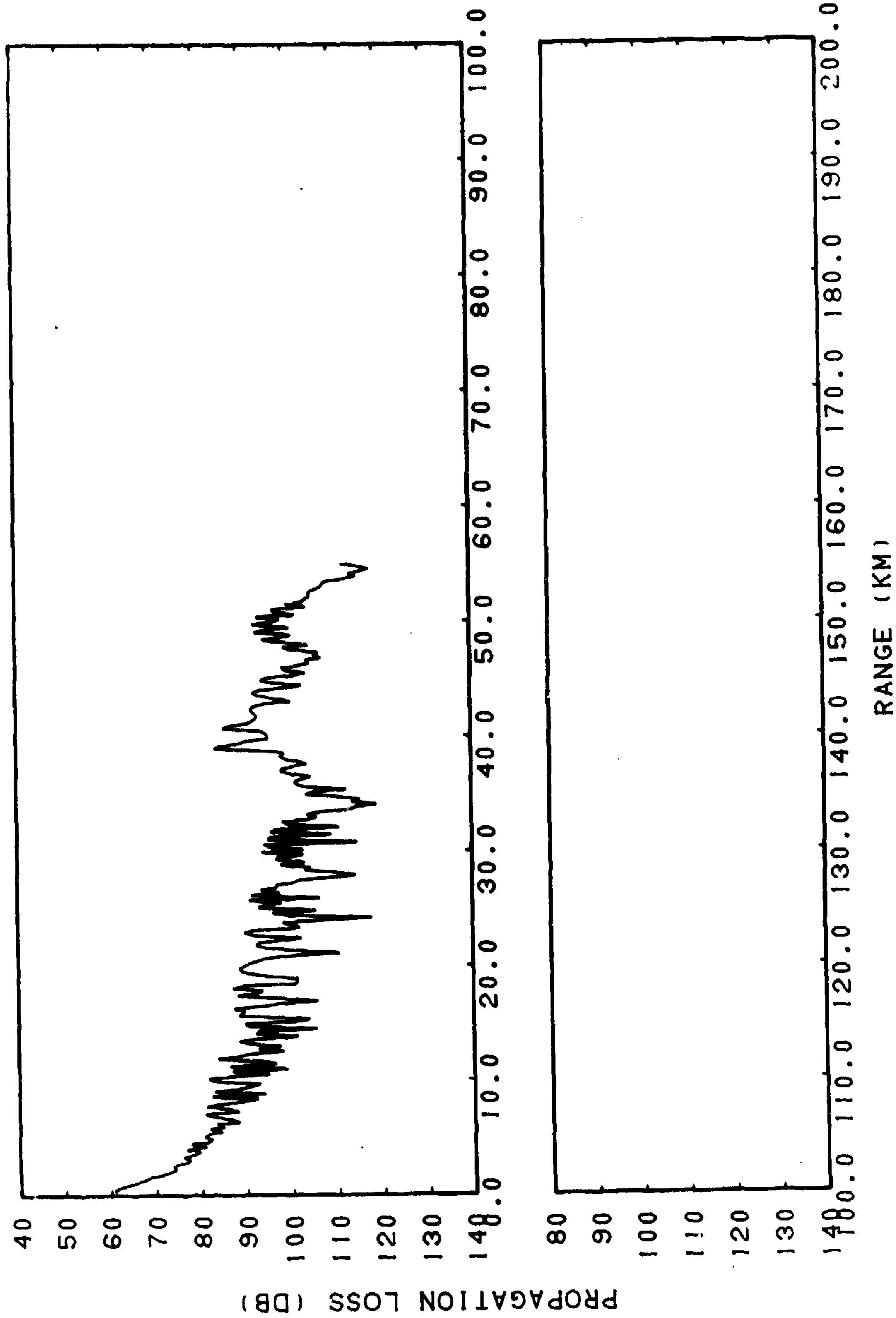
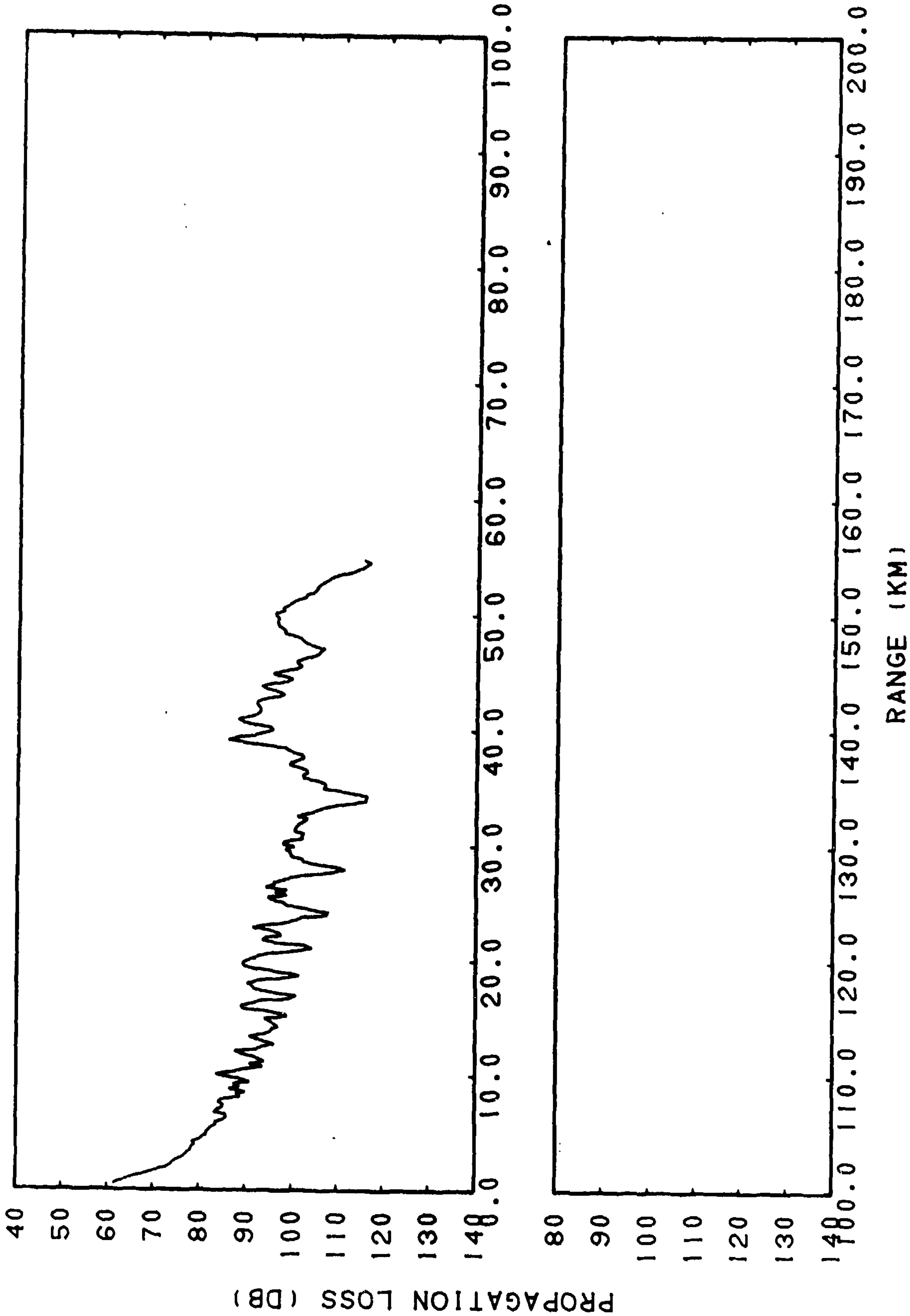
(C) Figure IIF-15a. Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



CONFIDENTIAL

(C) Figure IIF-15b. FACT Coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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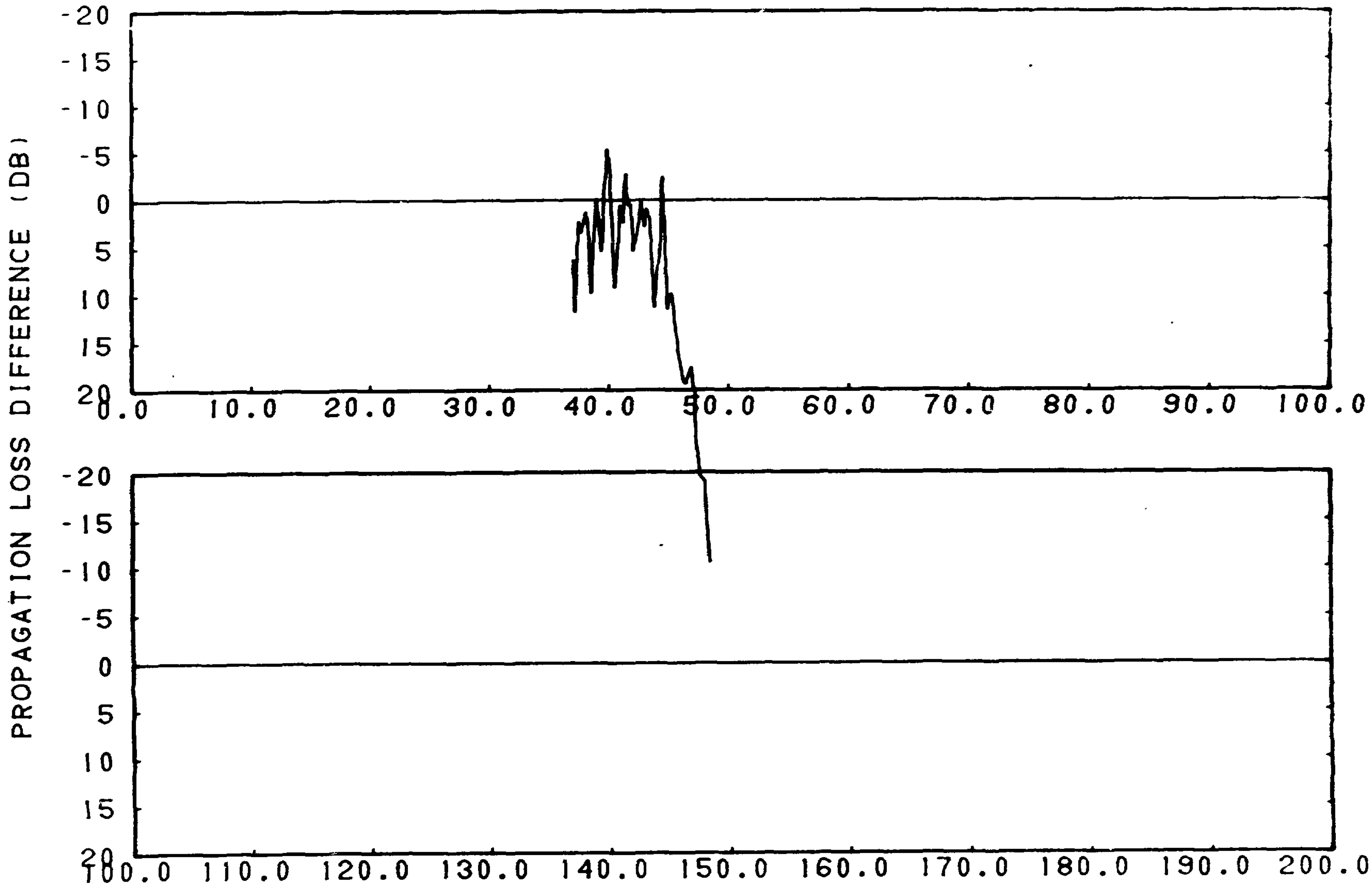
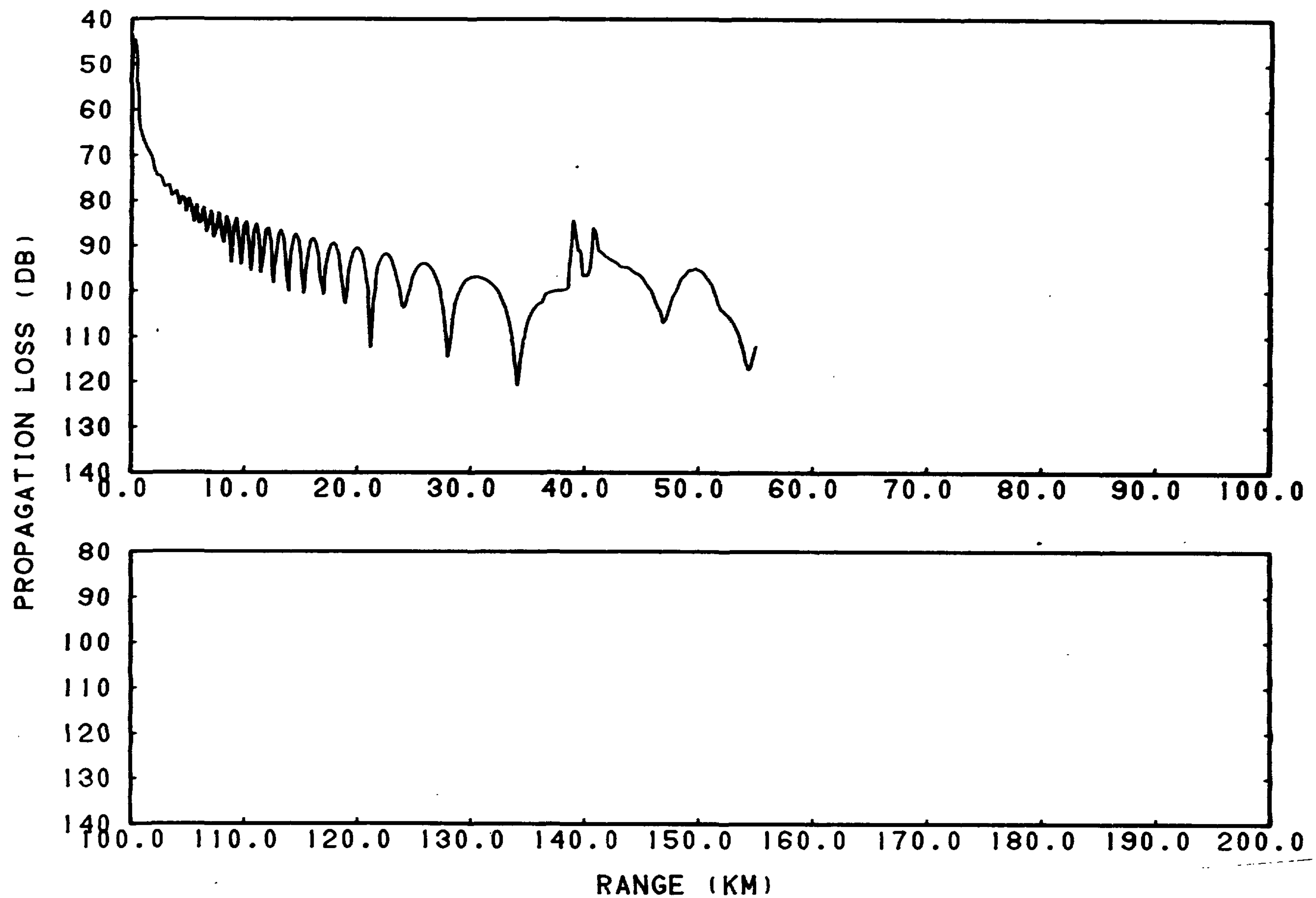
(C) Figure IIF-15c. FACT Coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



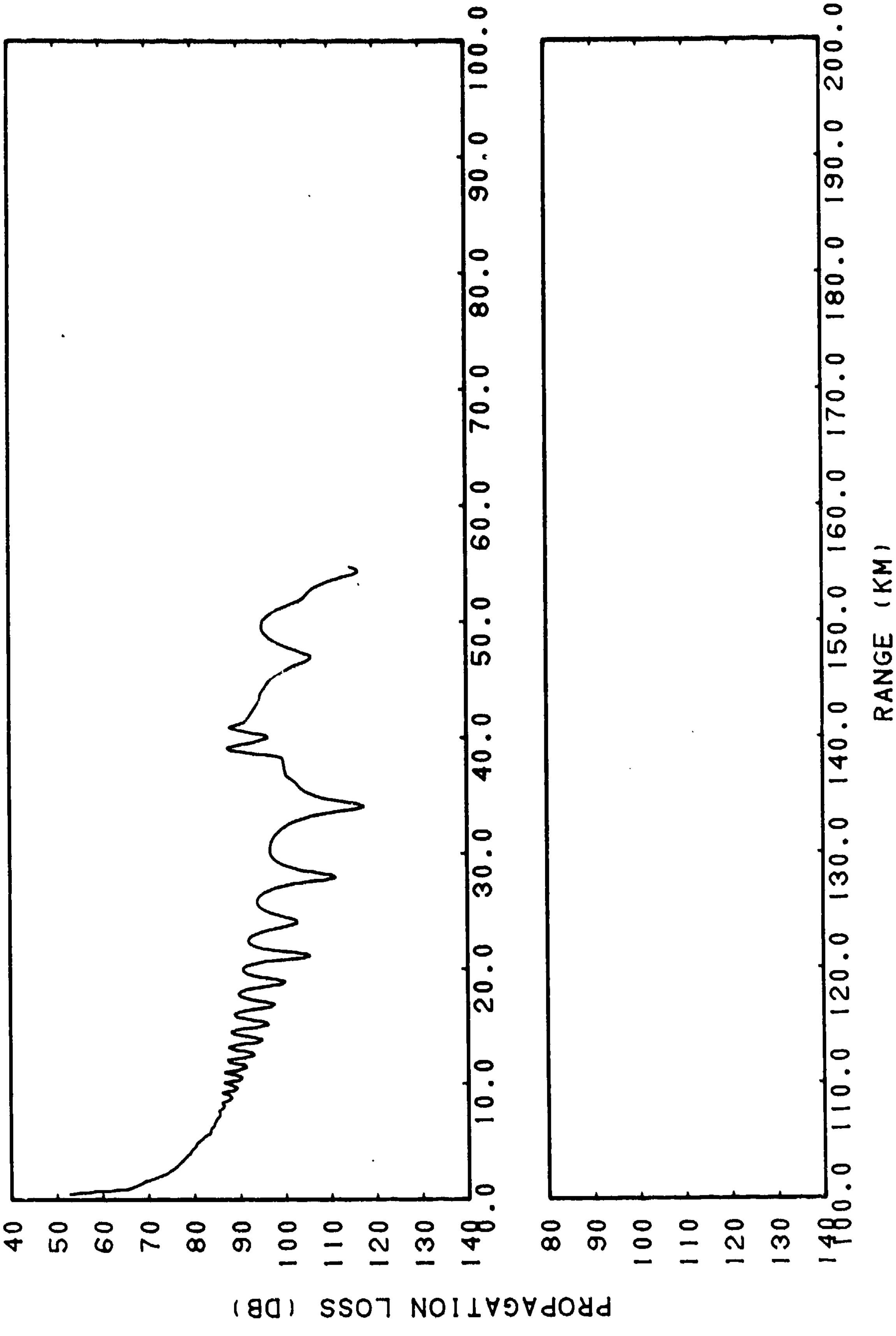
CONFIDENTIAL

(C) Figure IIF-15d. Smoothed FACT Coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Subtracted from Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



CONFIDENTIAL

(C) Figure IIF-15e. FACT Semi-coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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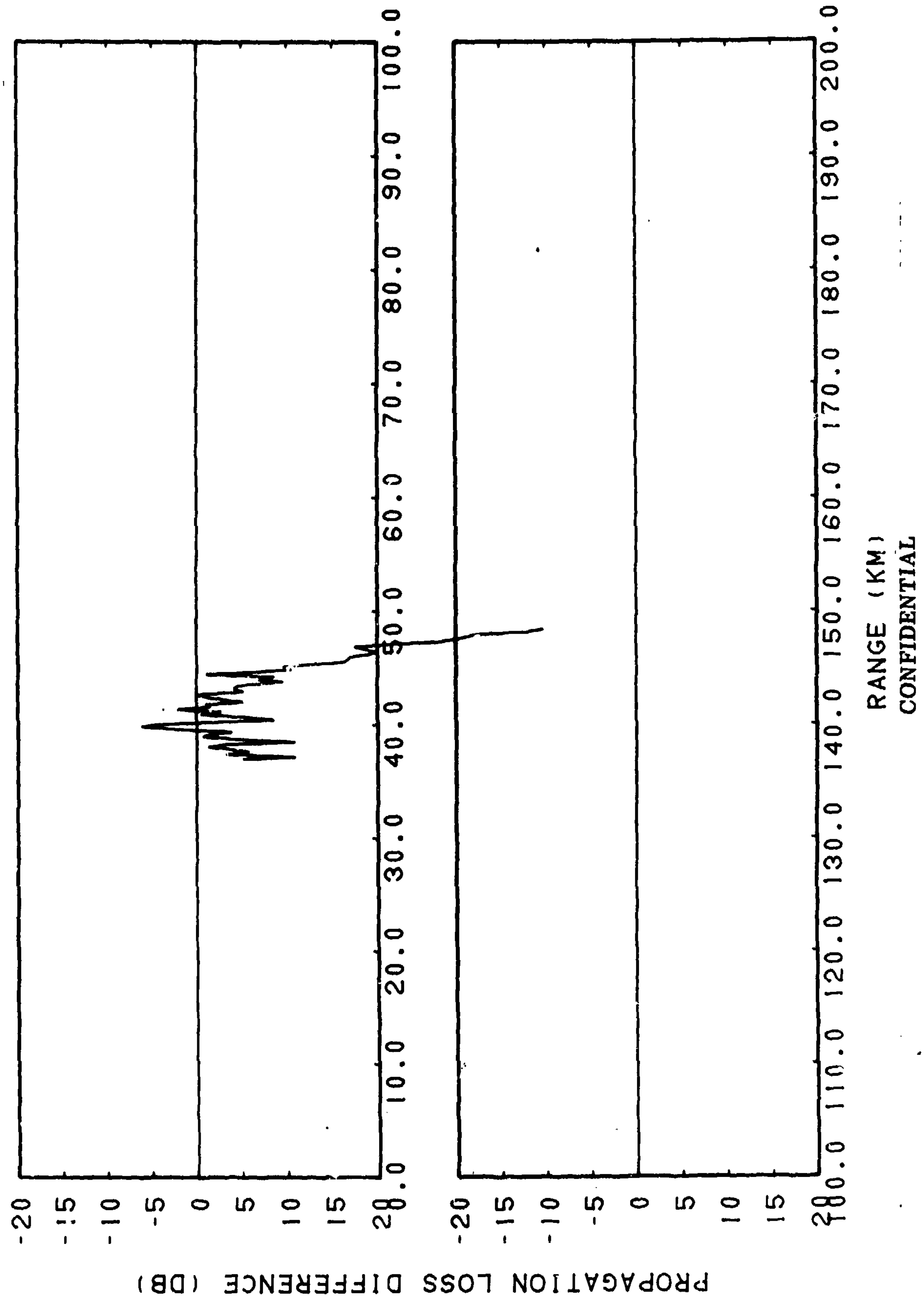
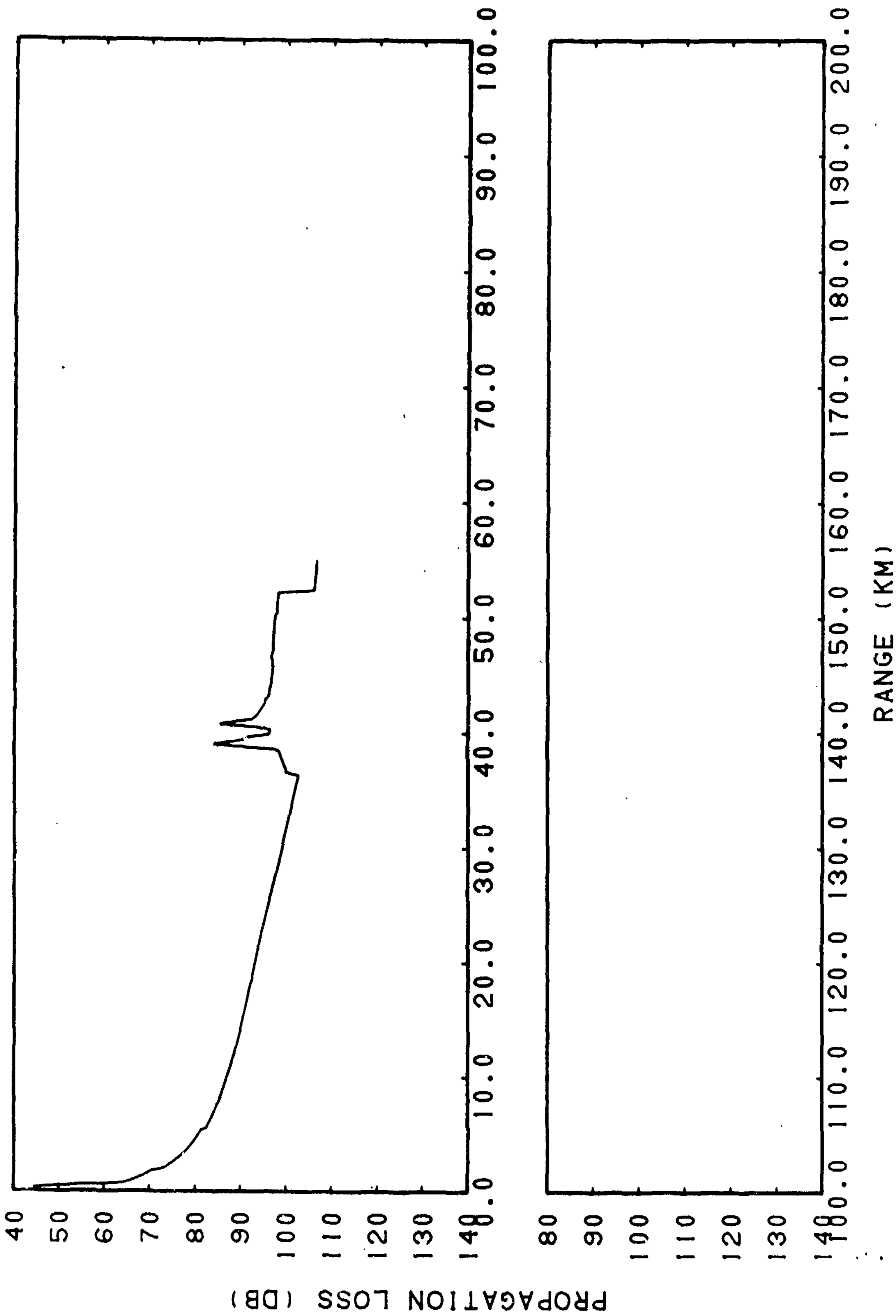
(C) Figure IIF-15f. FACT Semi-coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Sliding Averages of 3 Points (0.43 Kilometer)

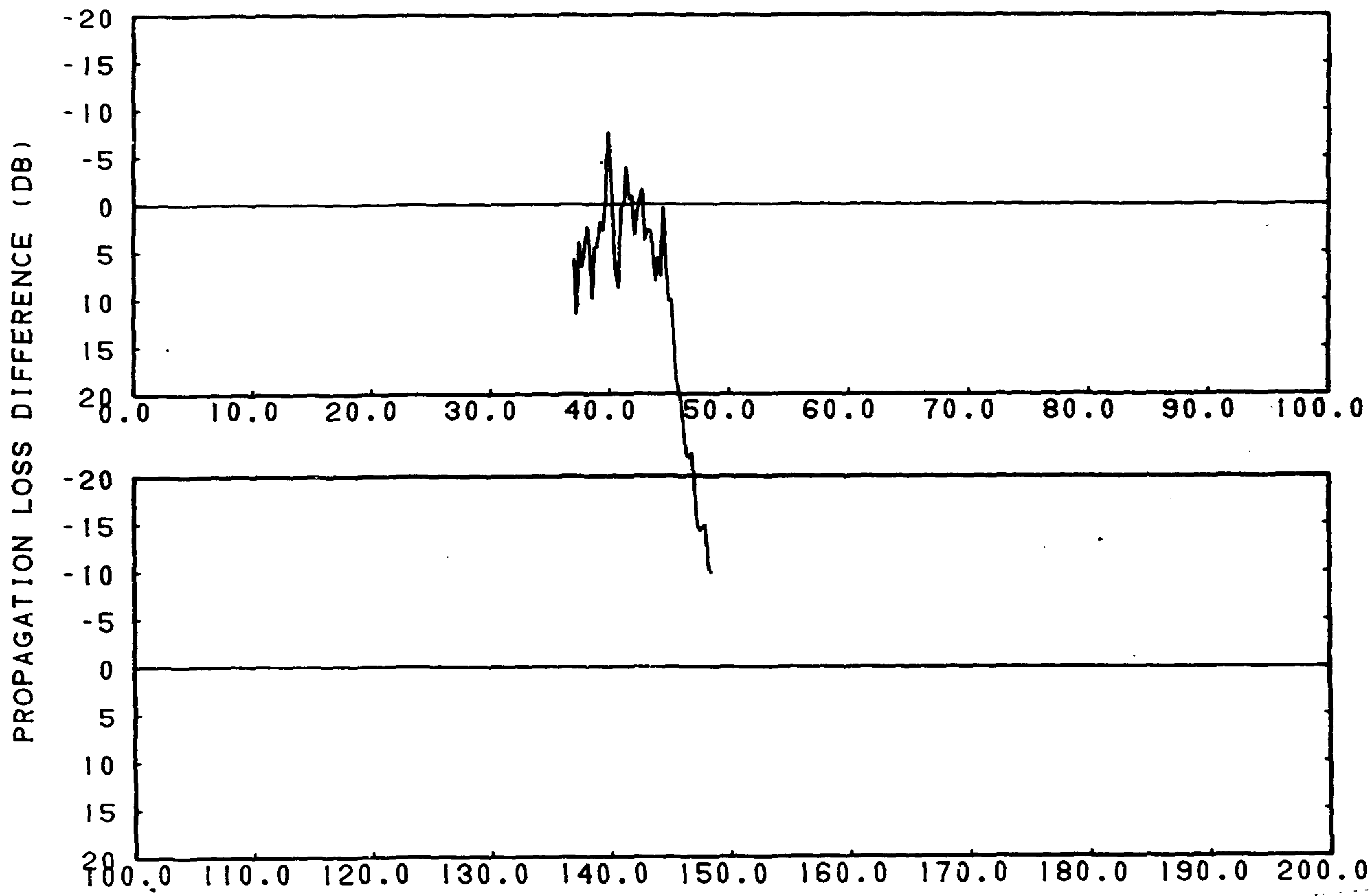


(C) Figure IIF-15g. Smoothed FACT Semi-coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Subtracted from Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



CONFIDENTIAL

(C) Figure IIF-15h. FACT Incoherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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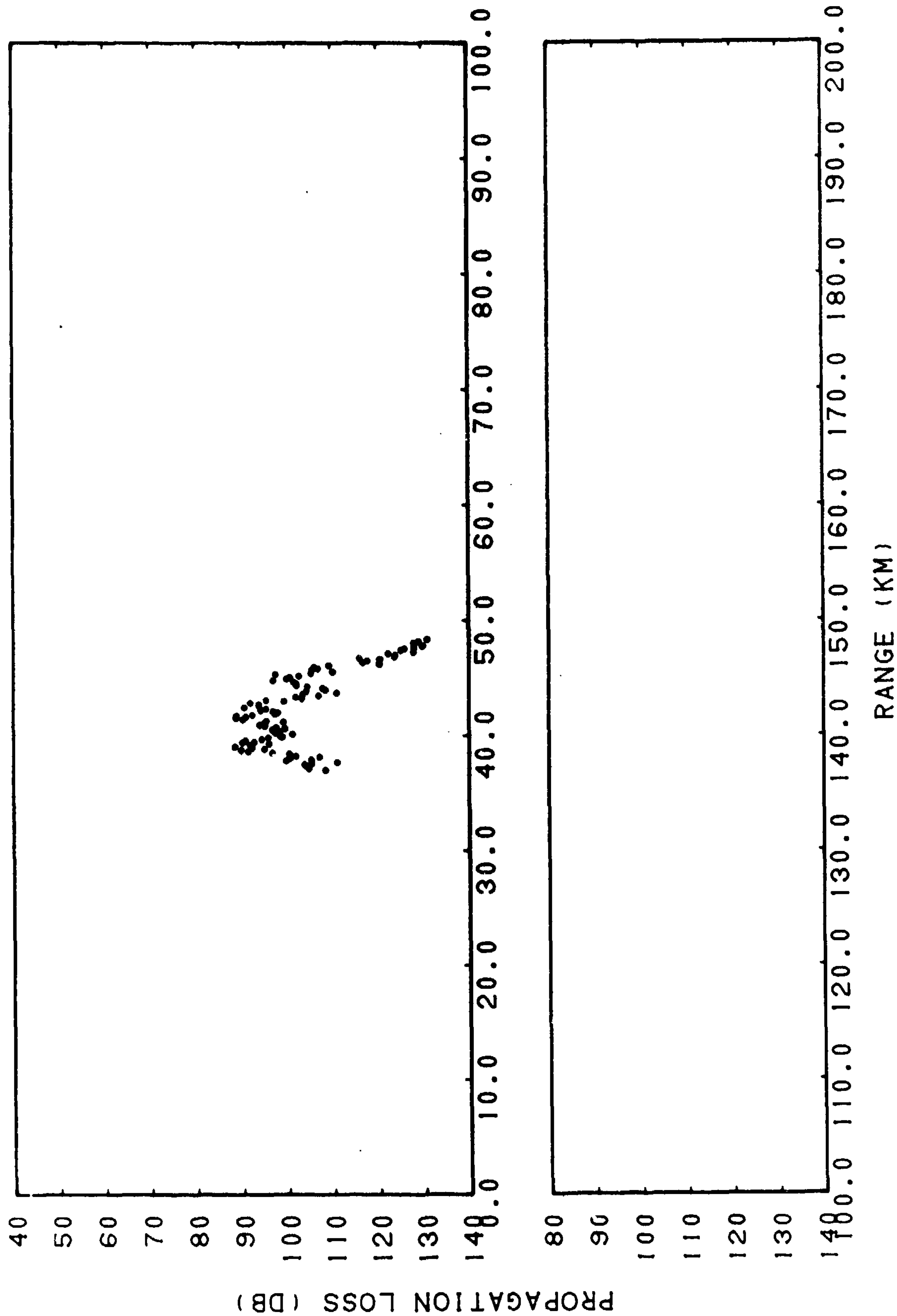
(C) Figure IIF-15i. FACT Incoherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Subtracted from Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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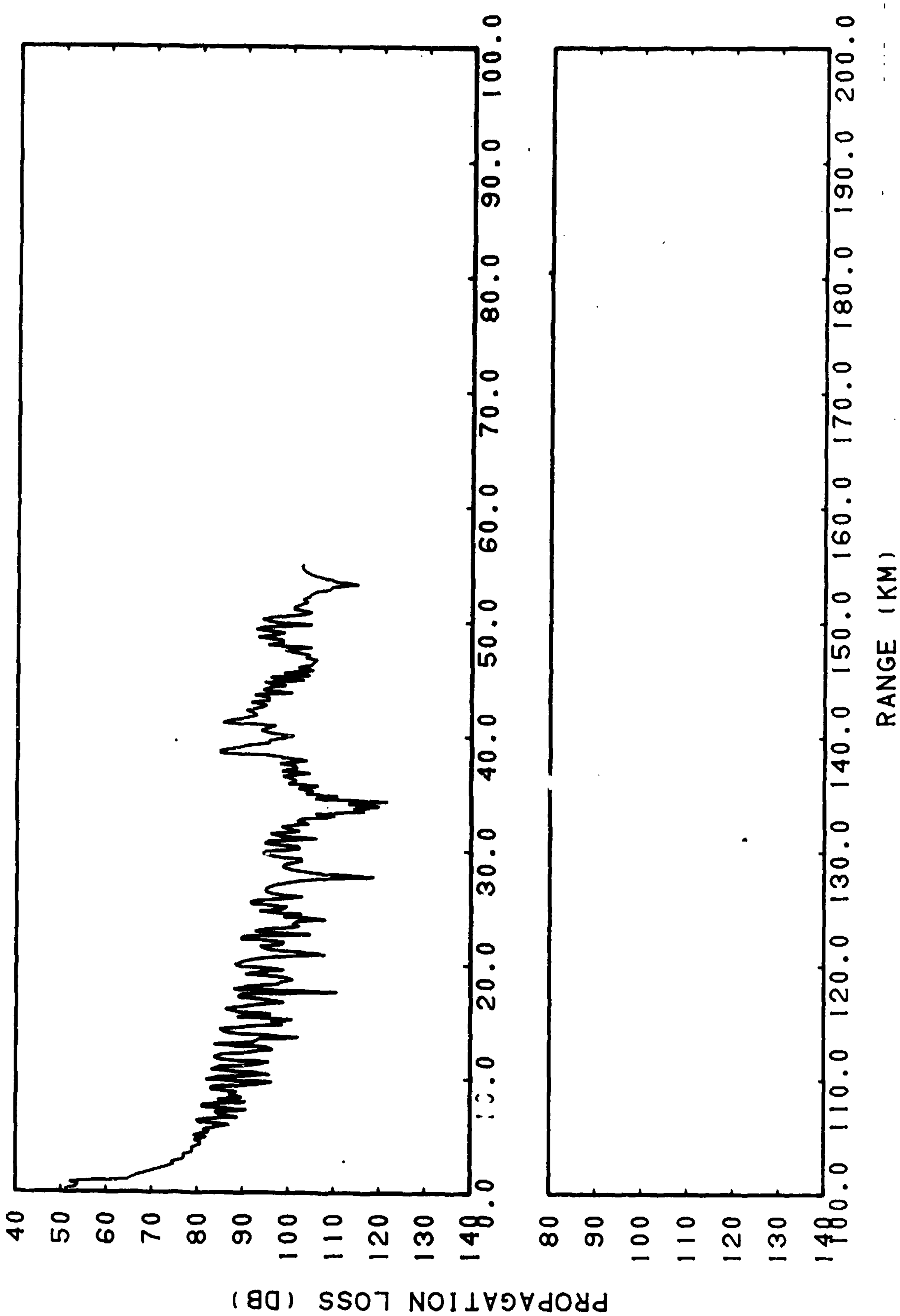
(C) Figure IIF-16a. Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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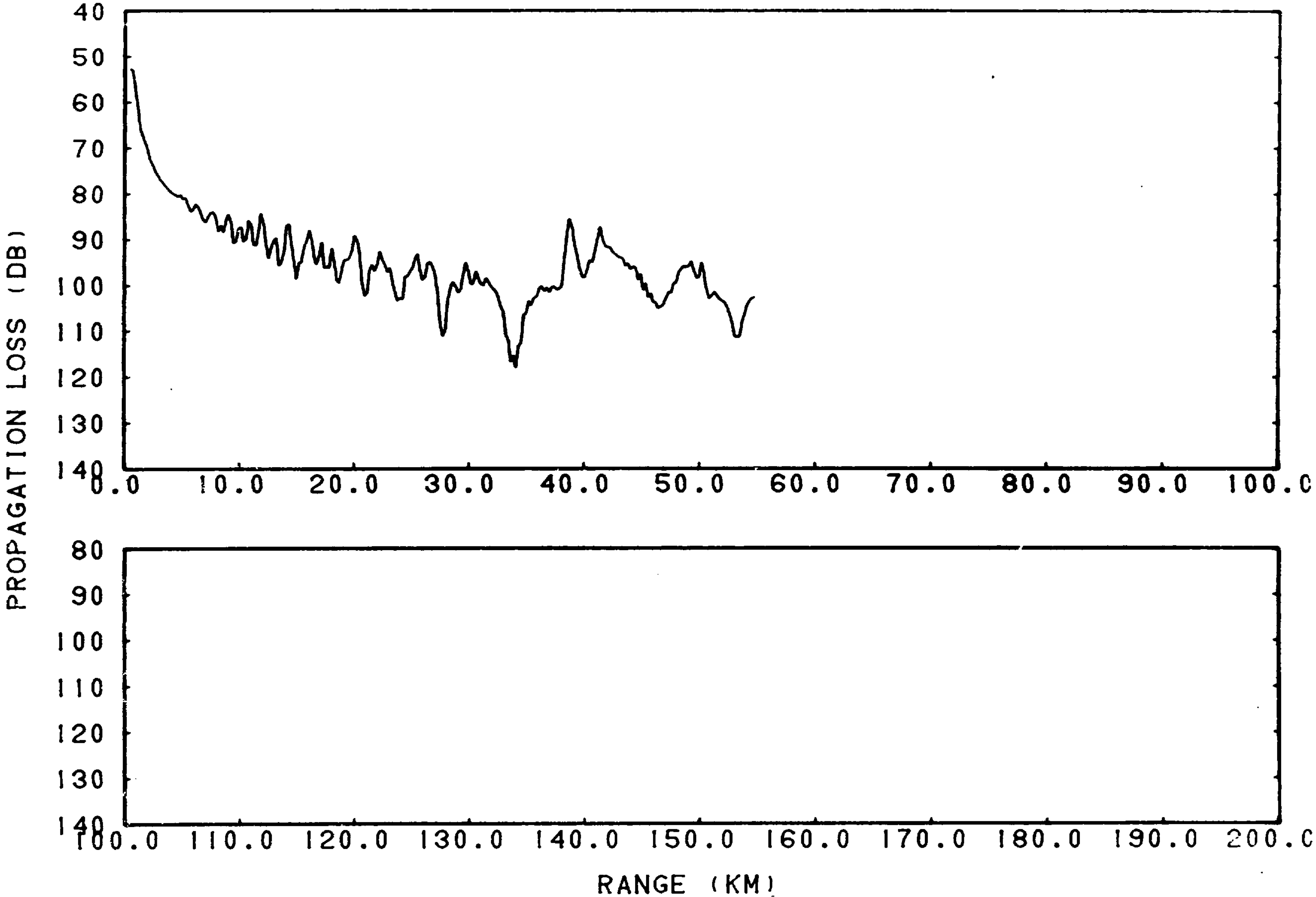
(C) Figure IIF-16b. FACT Coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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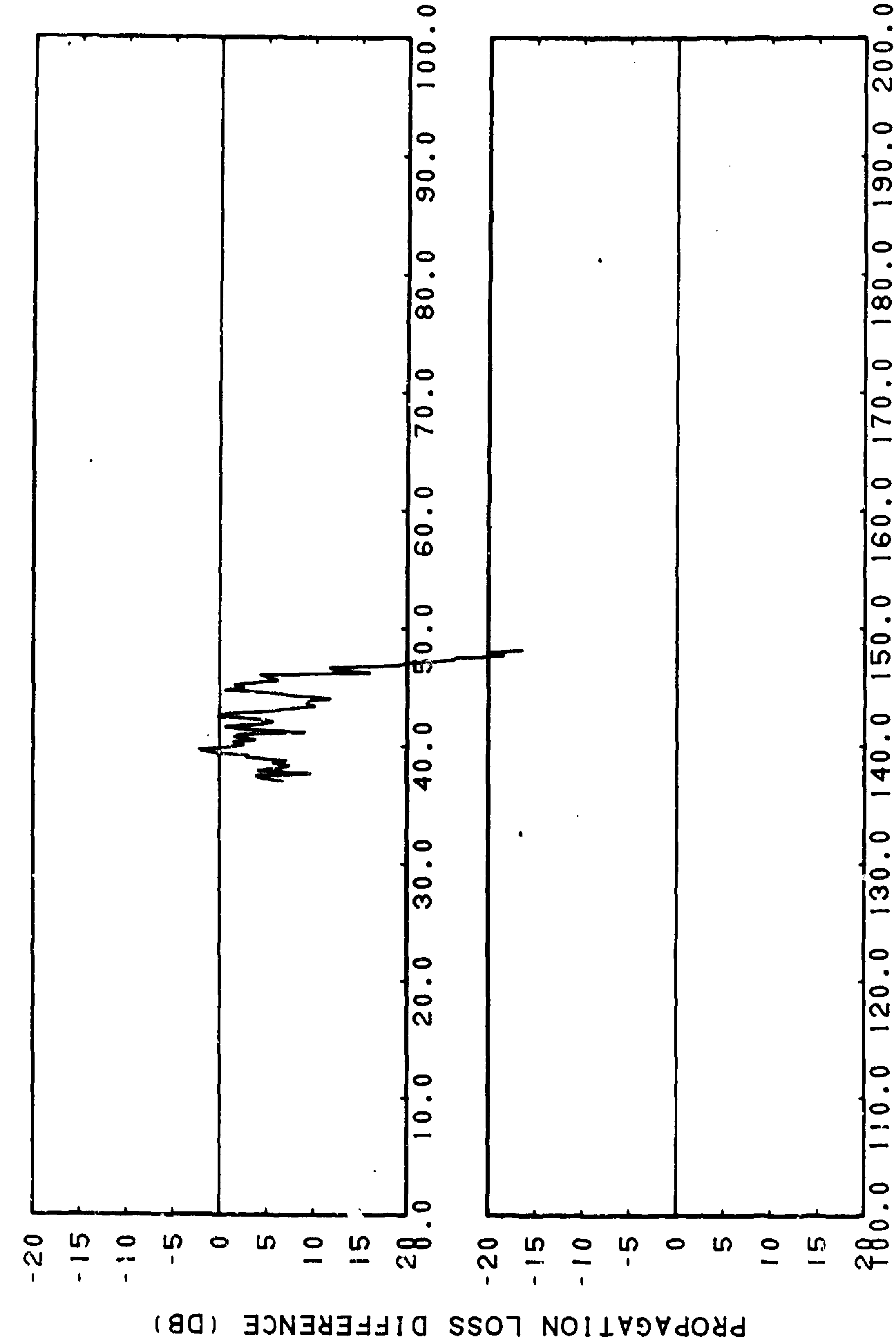
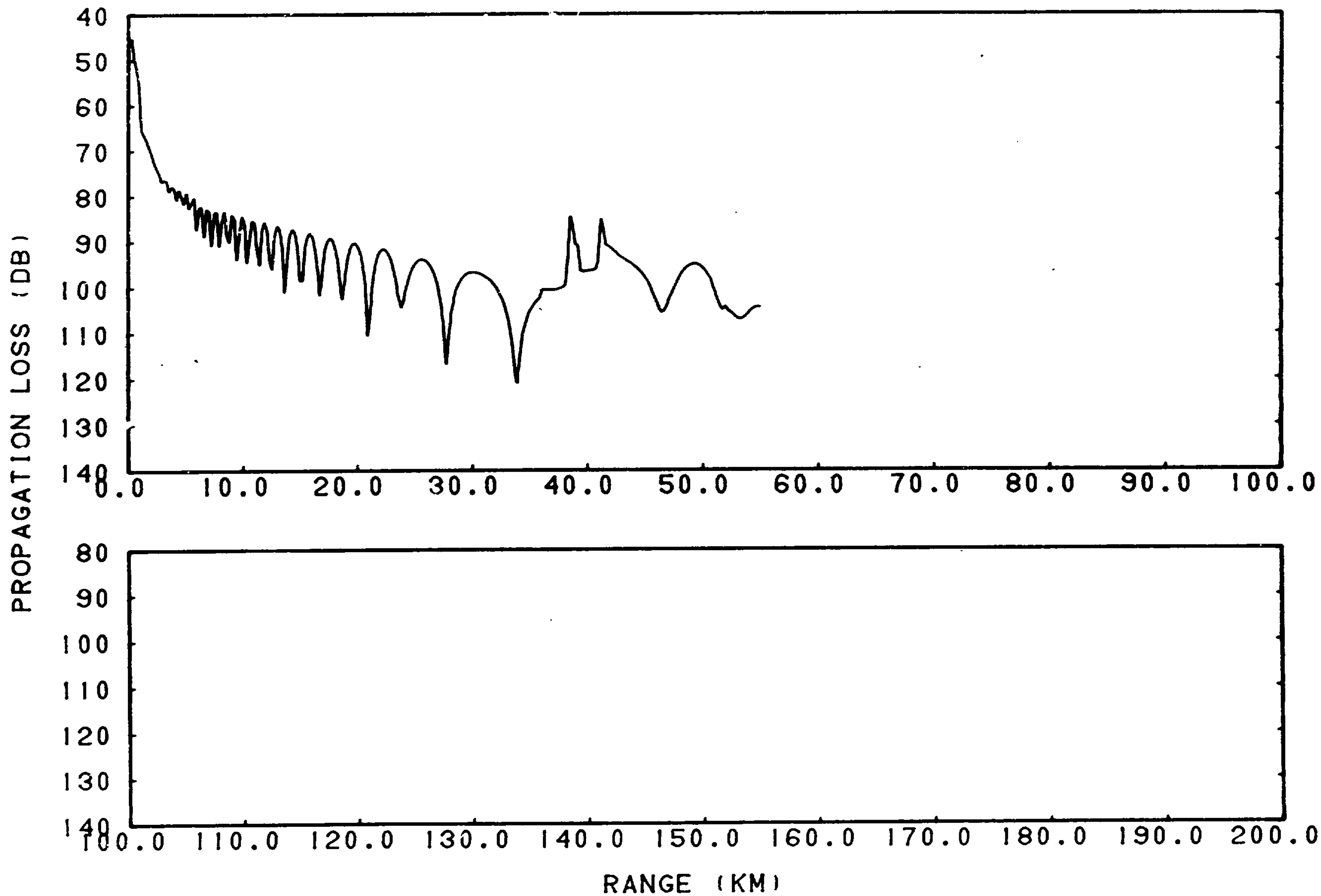
(C) Figure IIF-16c. FACT Coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



(C) Figure IIF-16d. Smoothed FACT Coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Subtracted from Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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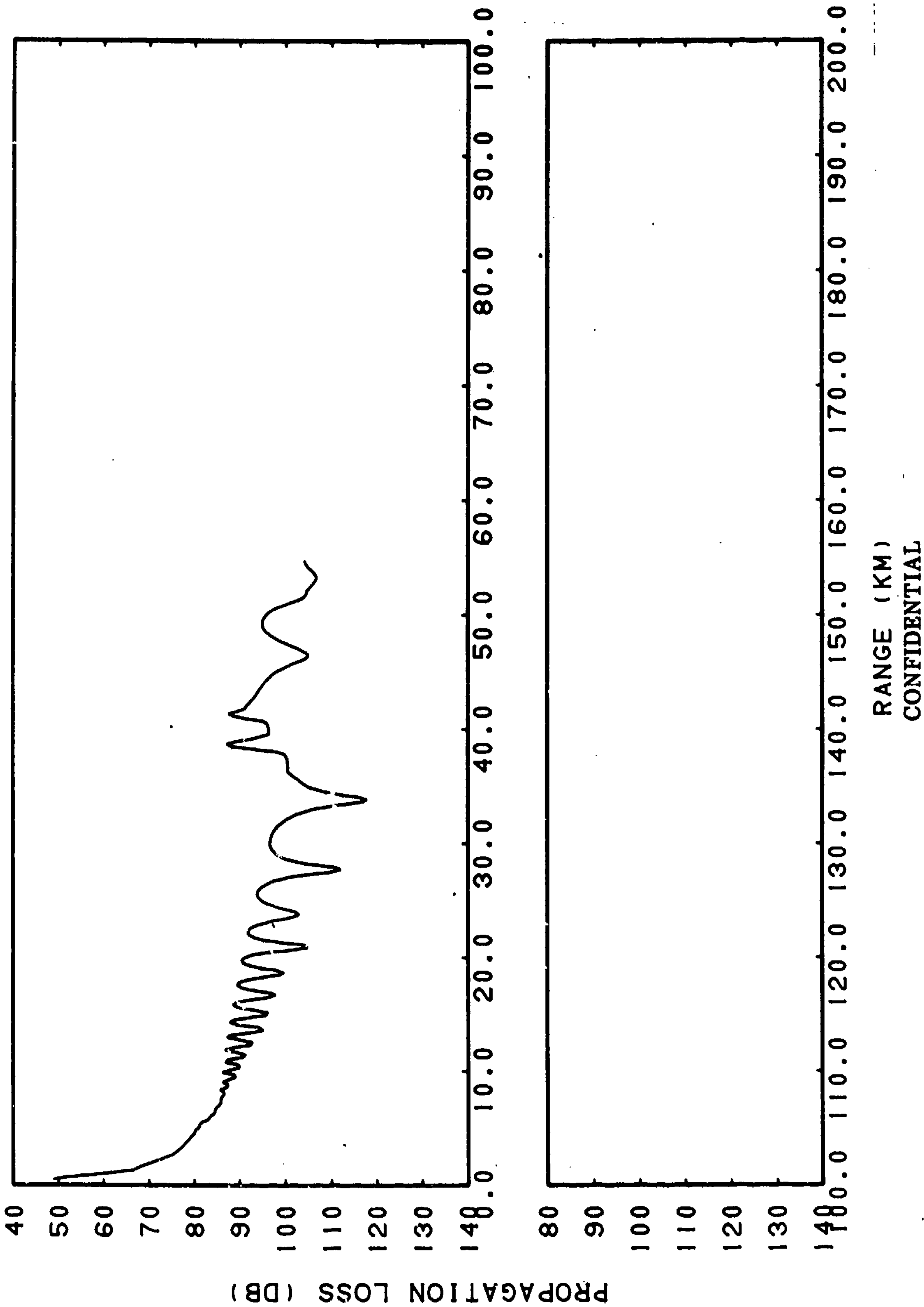
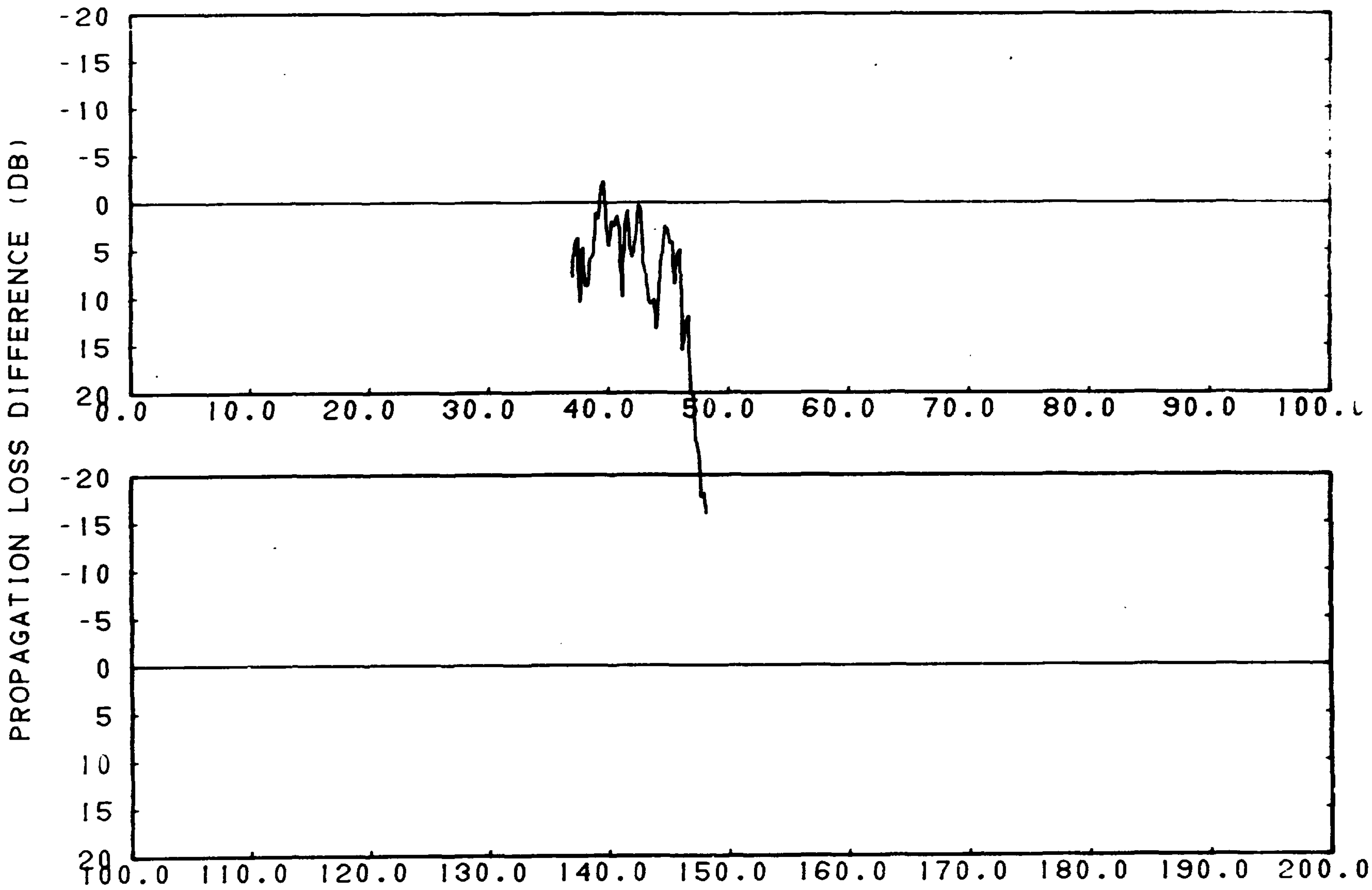
(C) Figure IIF-16e. FACT Semi-coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet



(C) Figure IIF-16f. FACT Semi-coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



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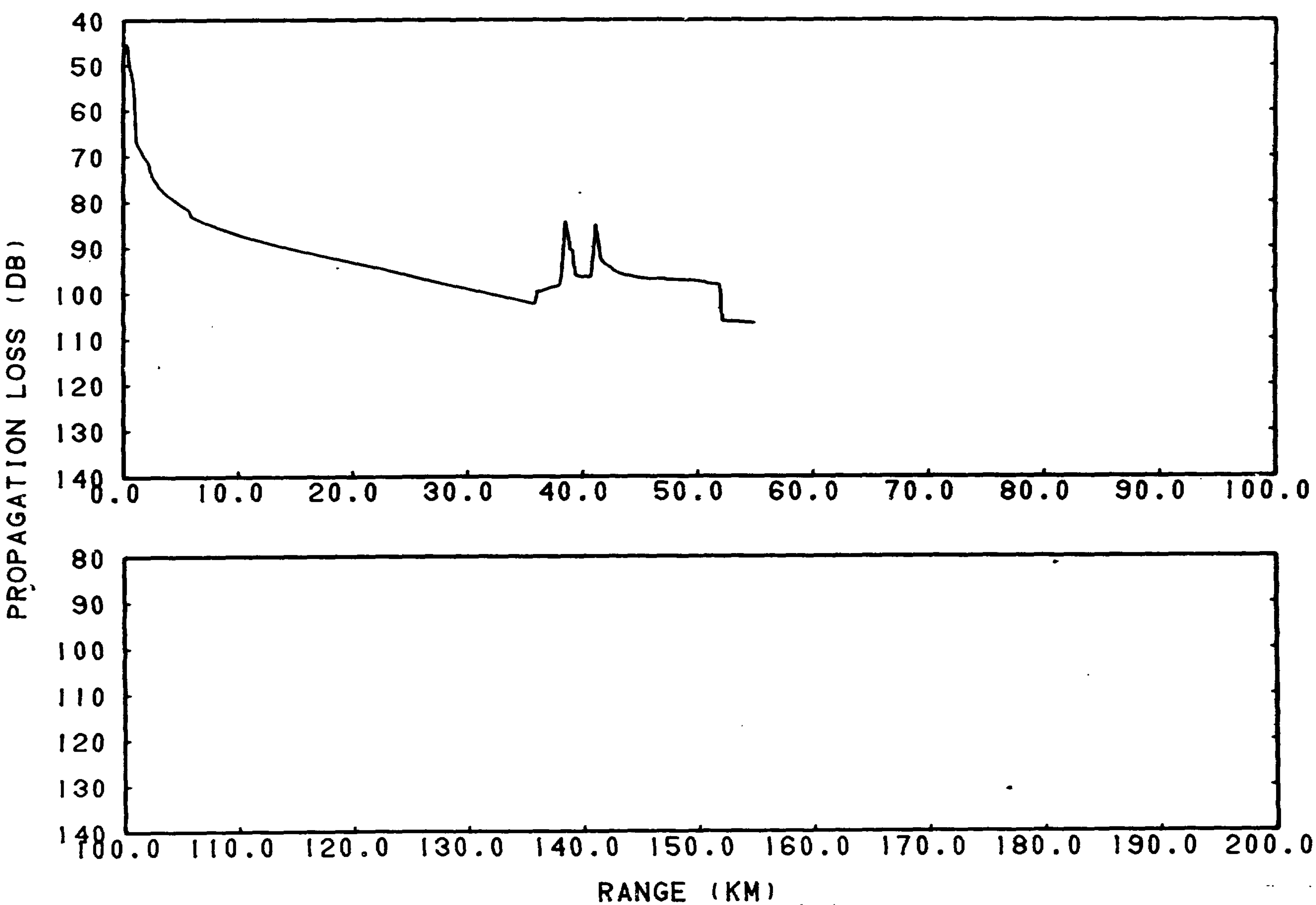
(C) Figure IIF-16g. Smoothed FACT Semi-coherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Subtracted from Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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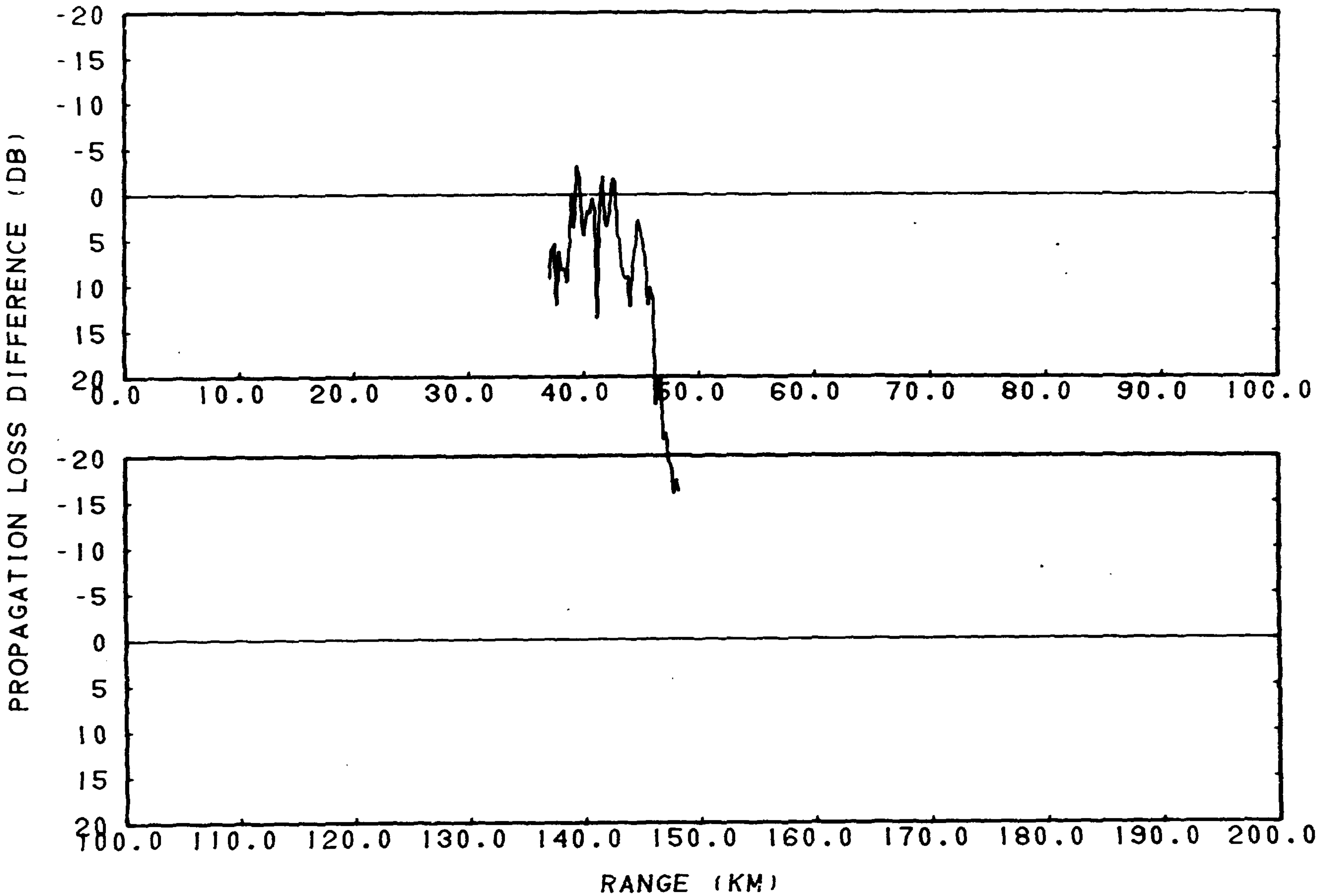
(C) Figure IIF-16h. FACT Incoherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet



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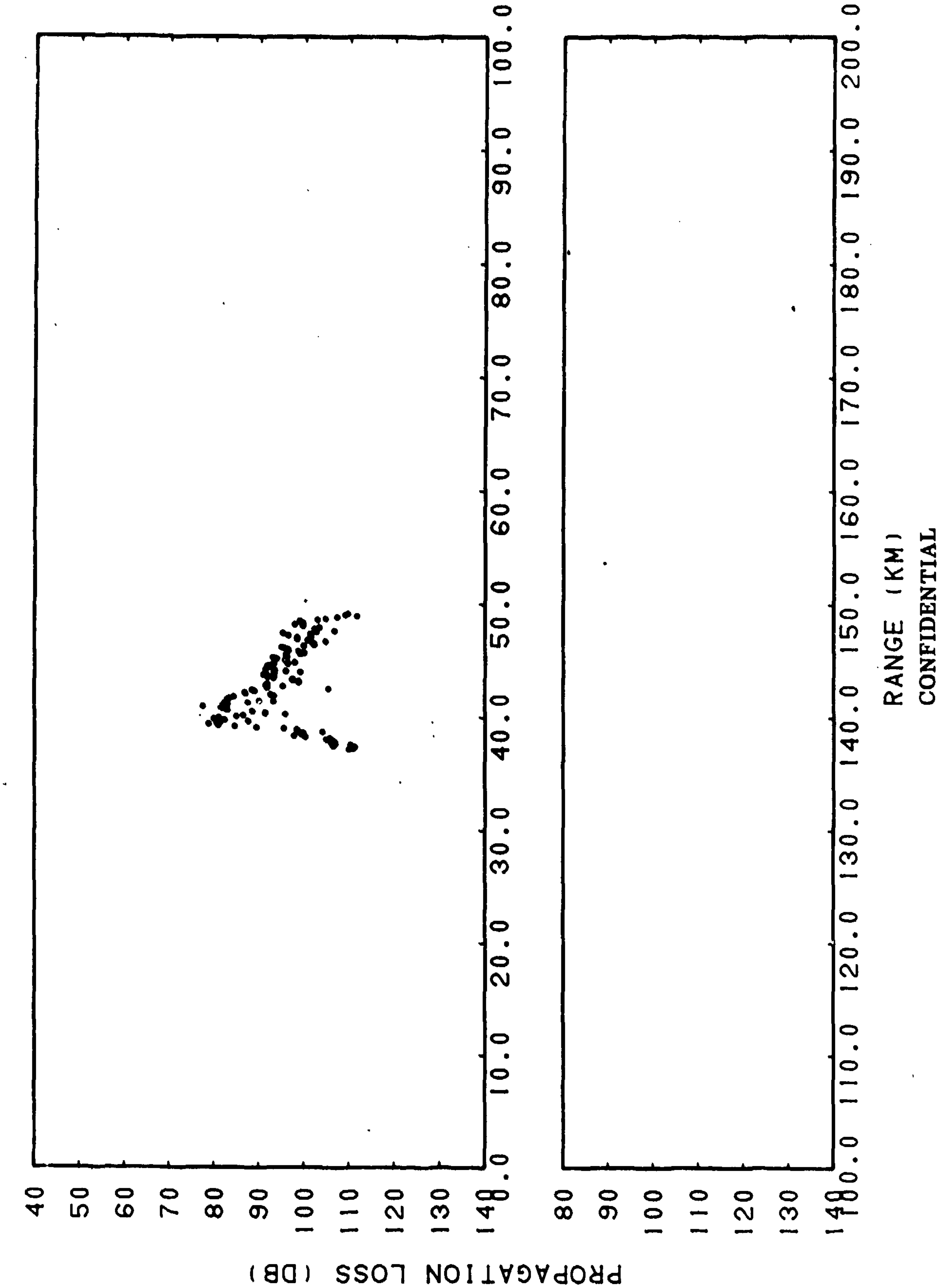
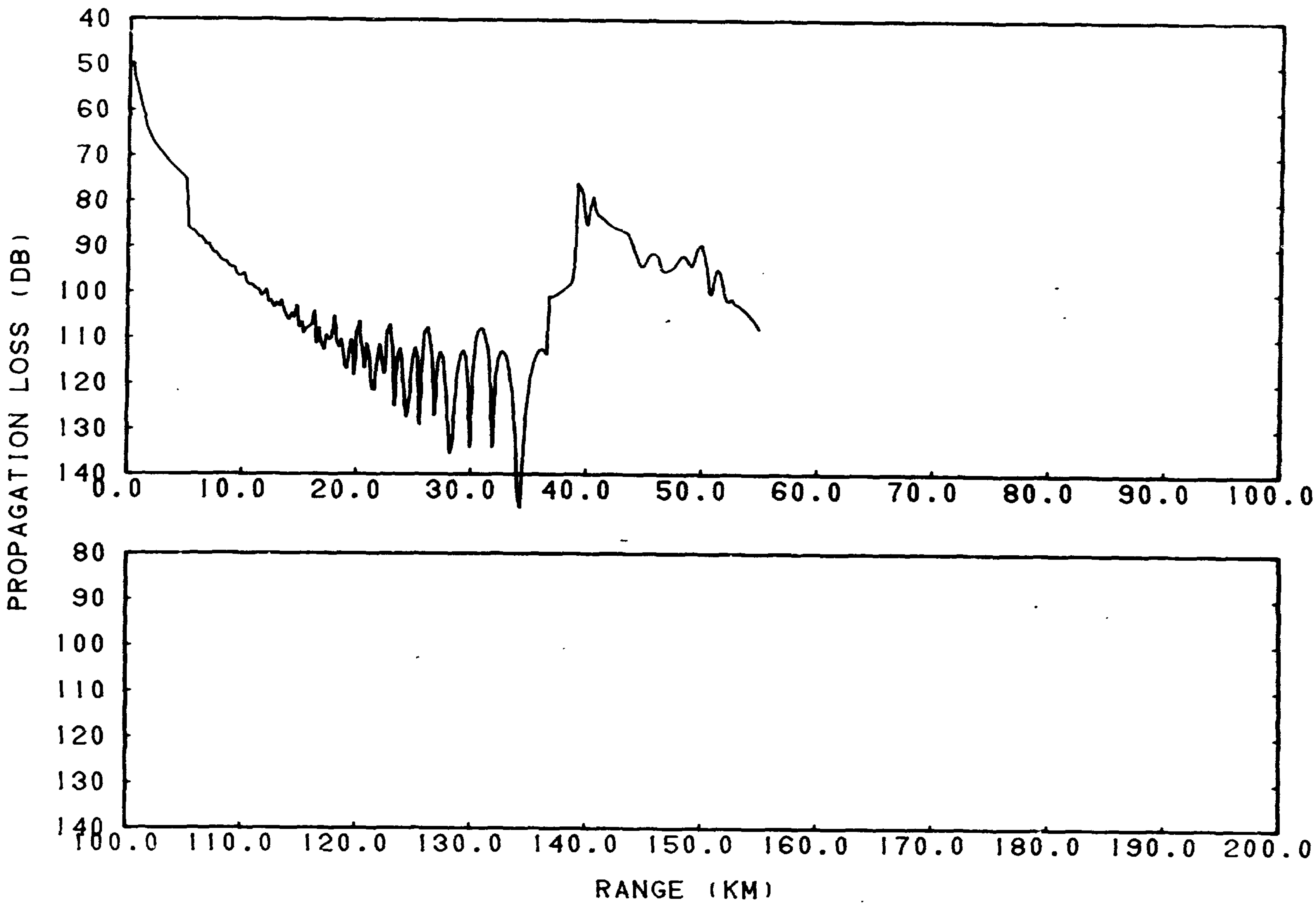
(C) Figure IIF-16i. FACT Incoherent Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Subtracted from Station 3 Run 43, Source Depth = 20 Feet, Receiver Depth = 535 Feet

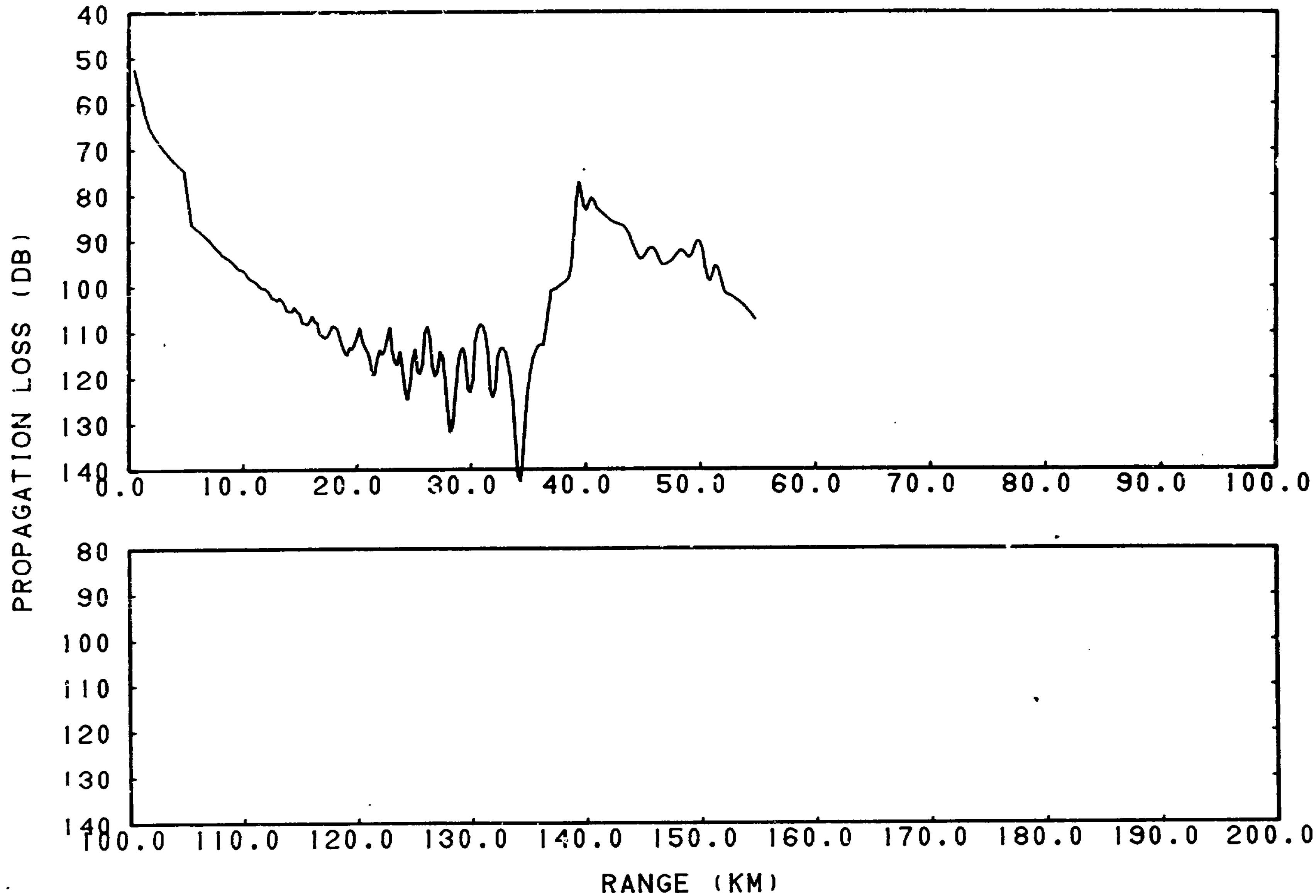


(C) Figure IIF-17a. Station 3 Run 103, Source Depth = 20 Feet, Receiver Depth = 60 Feet



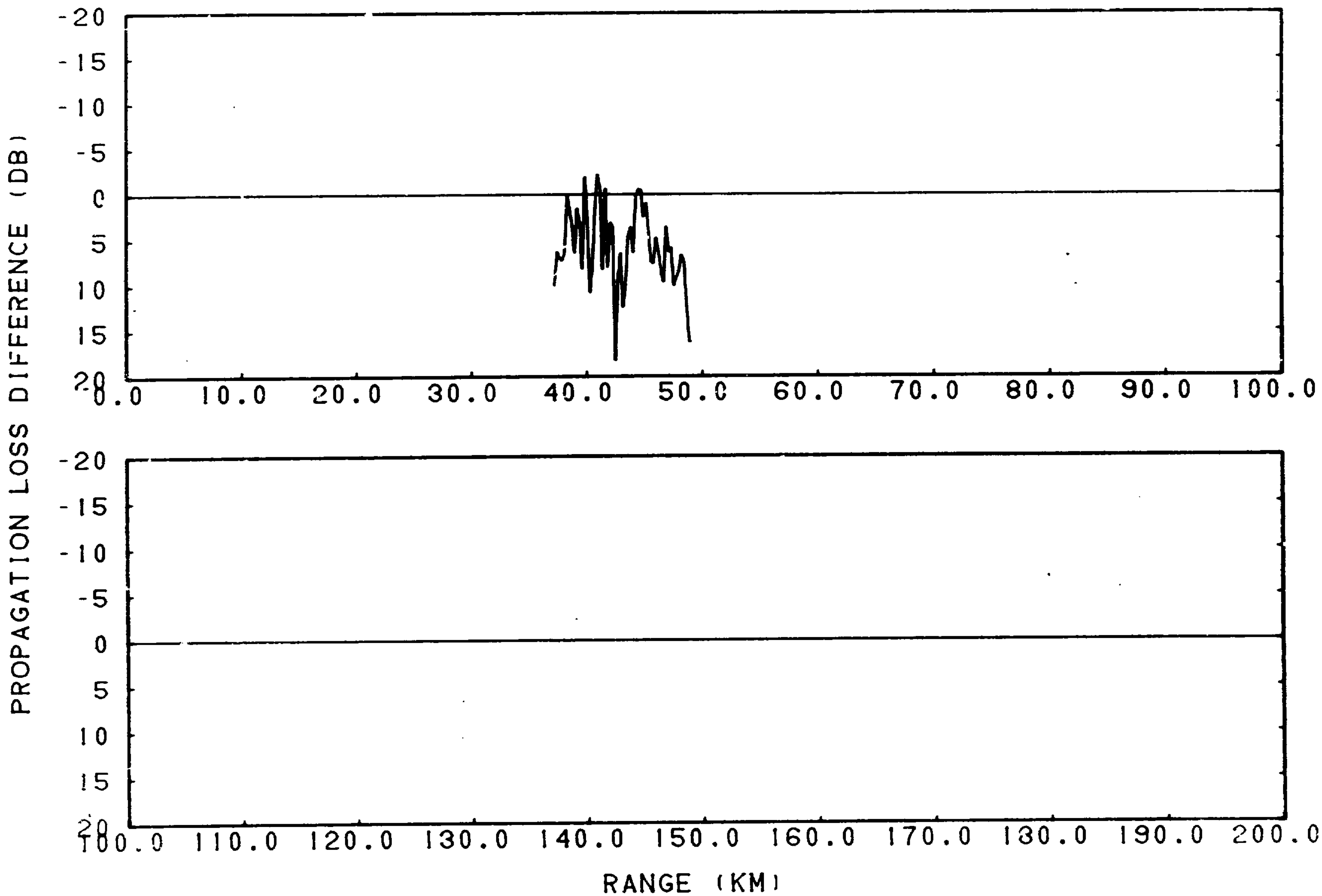
CONFIDENTIAL

(C) Figure IIF-17b. FACT Coherent Station 3 Run 103, Source Depth = 20 Feet, Receiver Depth = 60 Feet



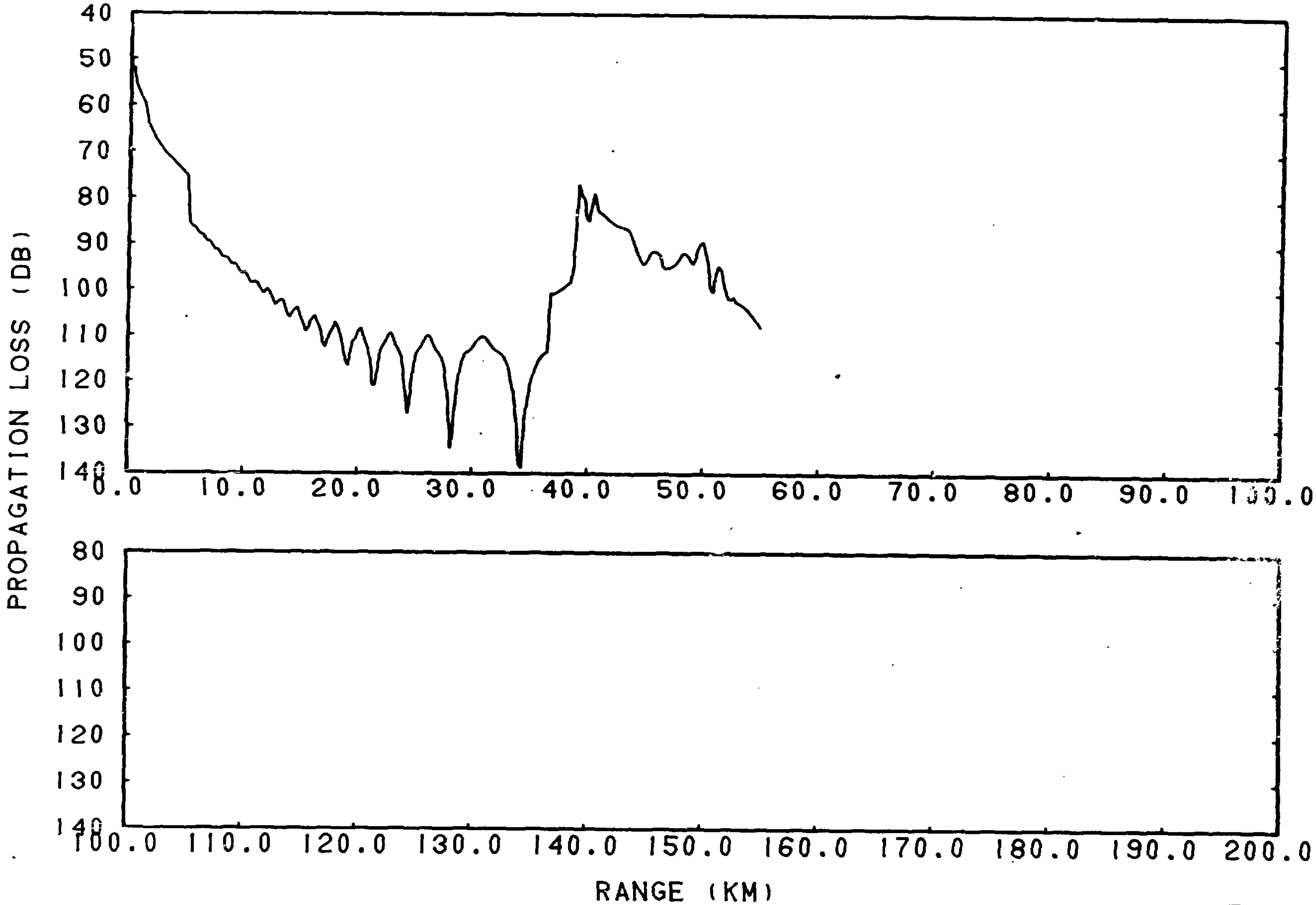
CONFIDENTIAL

(C) Figure IIF-17c. FACT Coherent Station 3 Run 103, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



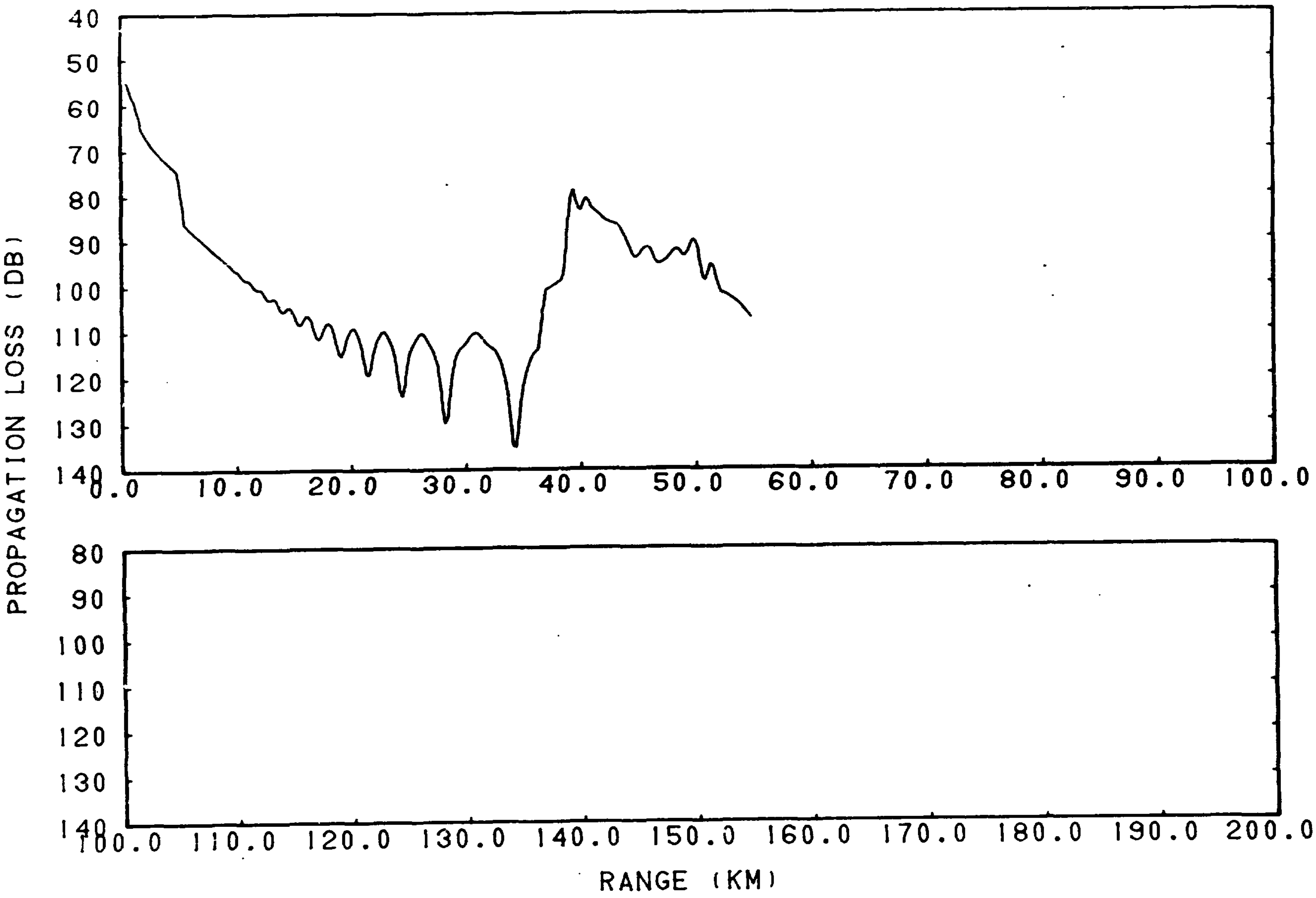
CONFIDENTIAL

(C) Figure IIF-17d. Smoothed FACT Coherent Station 3 Run 103, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 3 Run 103, Source Depth = 20 Feet, Receiver Depth = 60 Feet



CONFIDENTIAL

(C) Figure IIF-17e. FACT Semi-coherent Station 3 Run 103, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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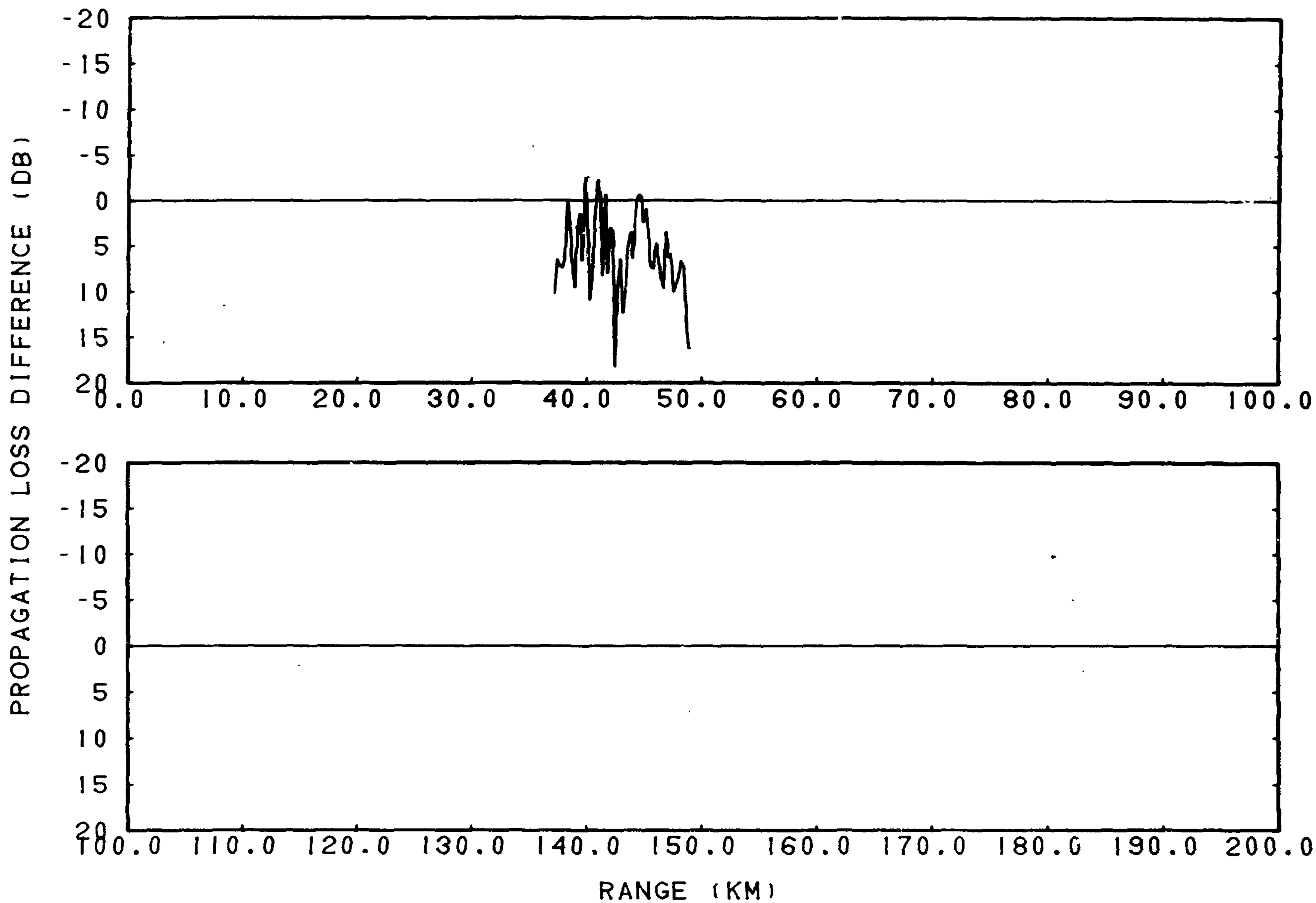
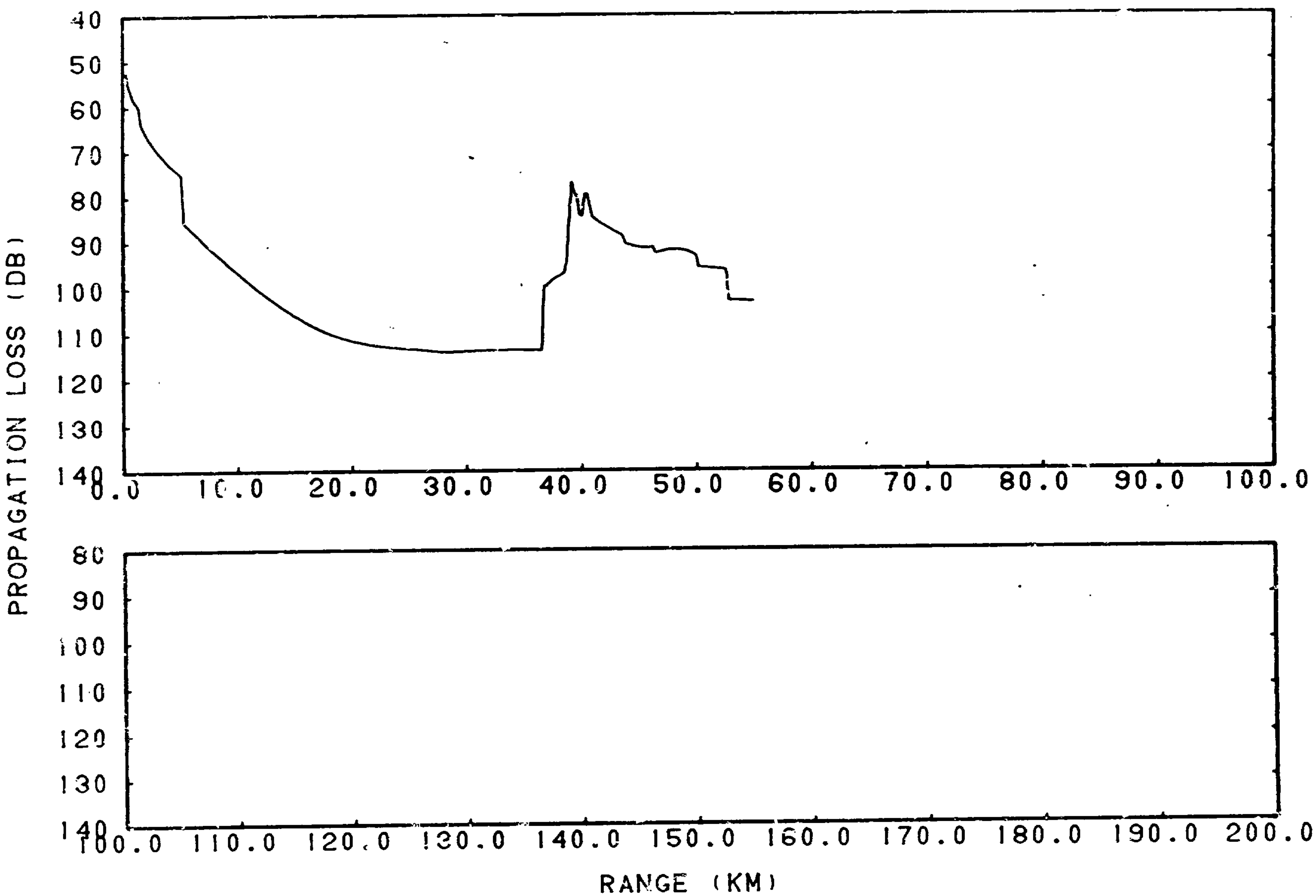
(C) Figure IIF-17f. FACT Semi-coherent Station 3 Run 103, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



CONFIDENTIAL

(C) Figure IIF-17g. Smoothed FACT Semi-coherent Station 3 Run 103, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 3 Run 103, Source Depth = 20 Feet, Receiver Depth = 60 Feet



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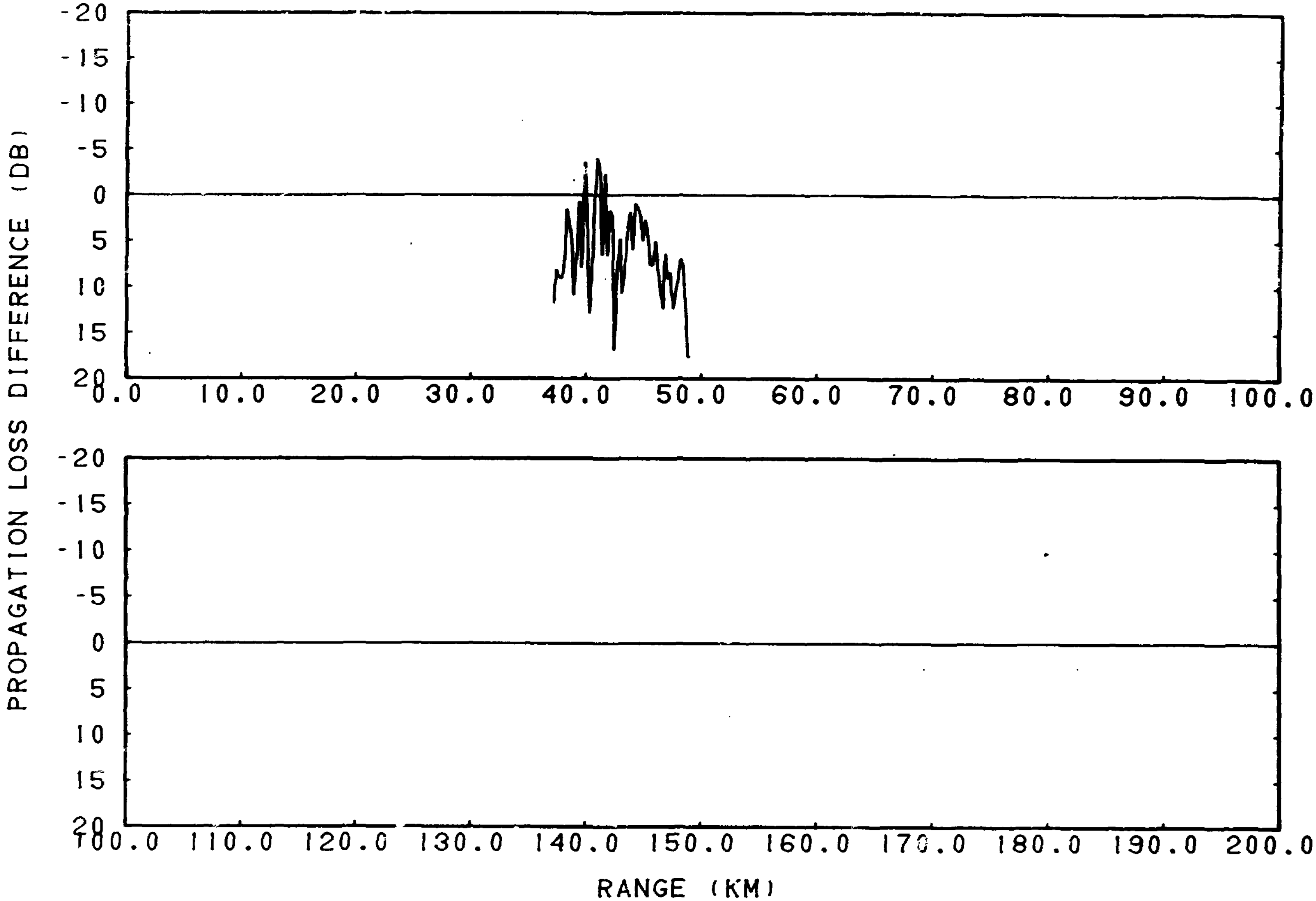
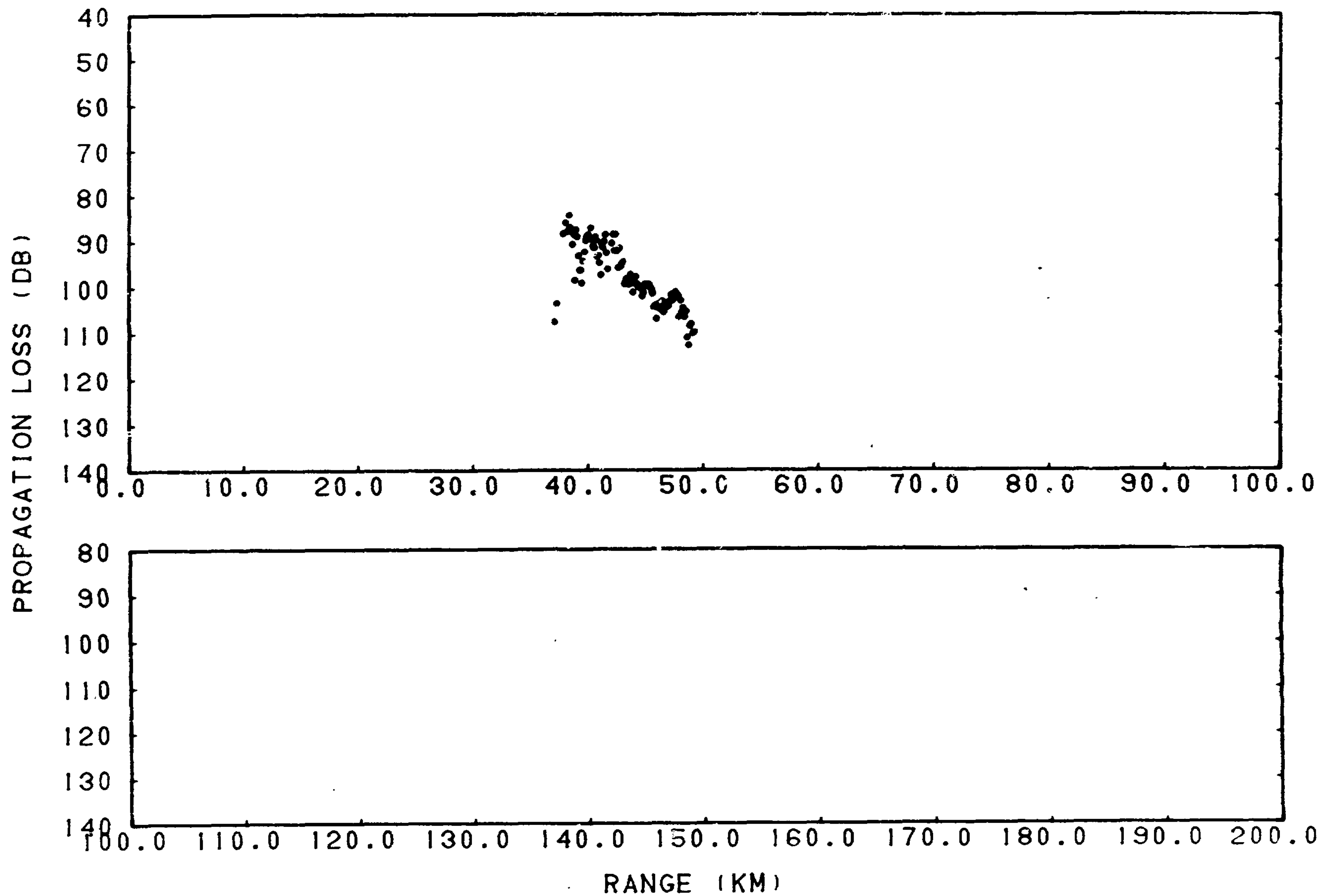
(C) Figure IIF-17h. FACT Incoherent Station 3 Run 103, Source Depth = 20 Feet, Receiver Depth = 60 Feet



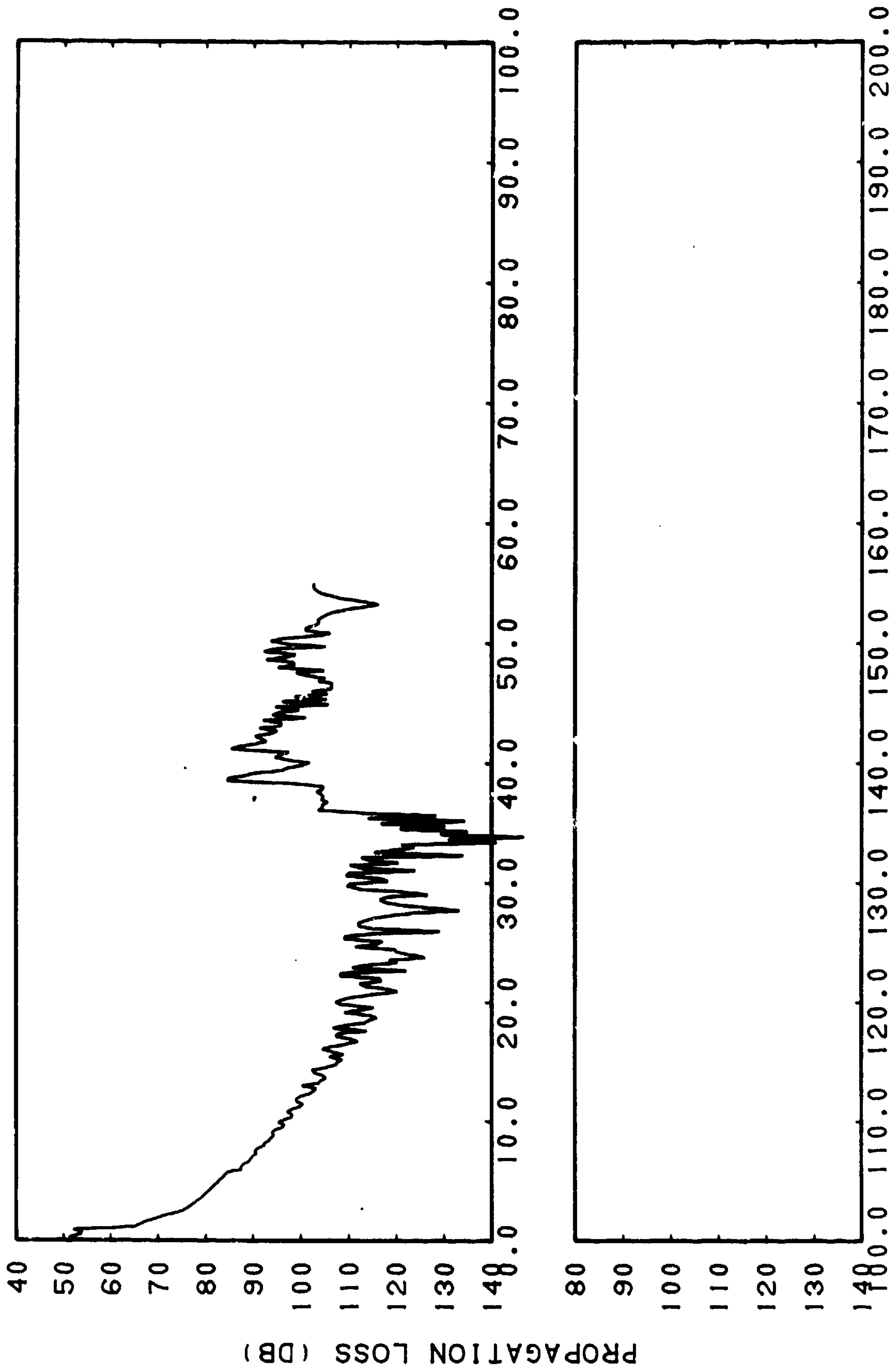
CONFIDENTIAL

(C) Figure IIF-17i. FACT Incoherent Station 3 Run 103, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 3 Run 103, Source Depth = 20 Feet, Receiver Depth = 60 Feet



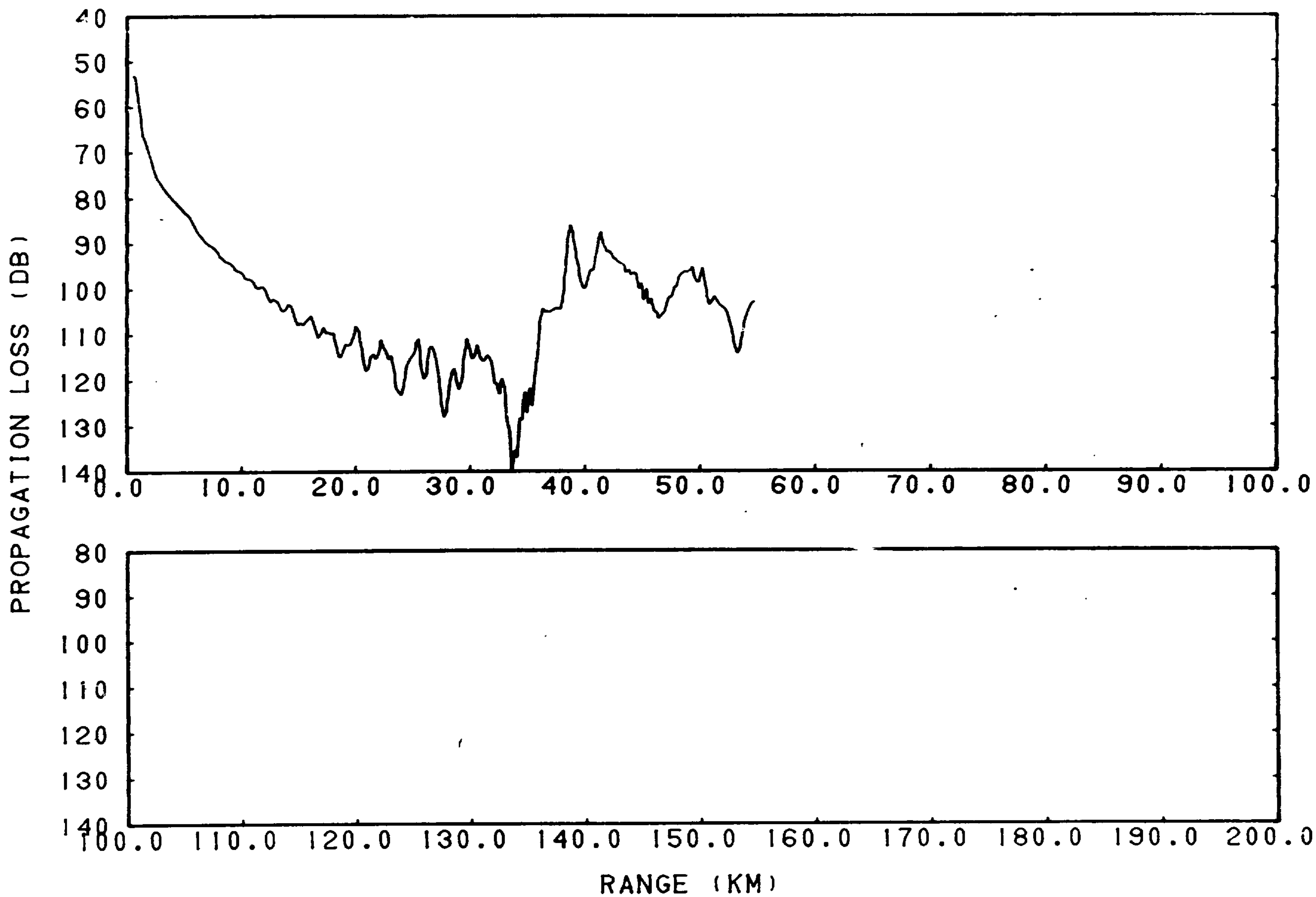
CONFIDENTIAL

(C) Figure IIF-18a. Station 3 Run 93, Source Depth = 20 Feet, Receiver Depth = 535 Feet



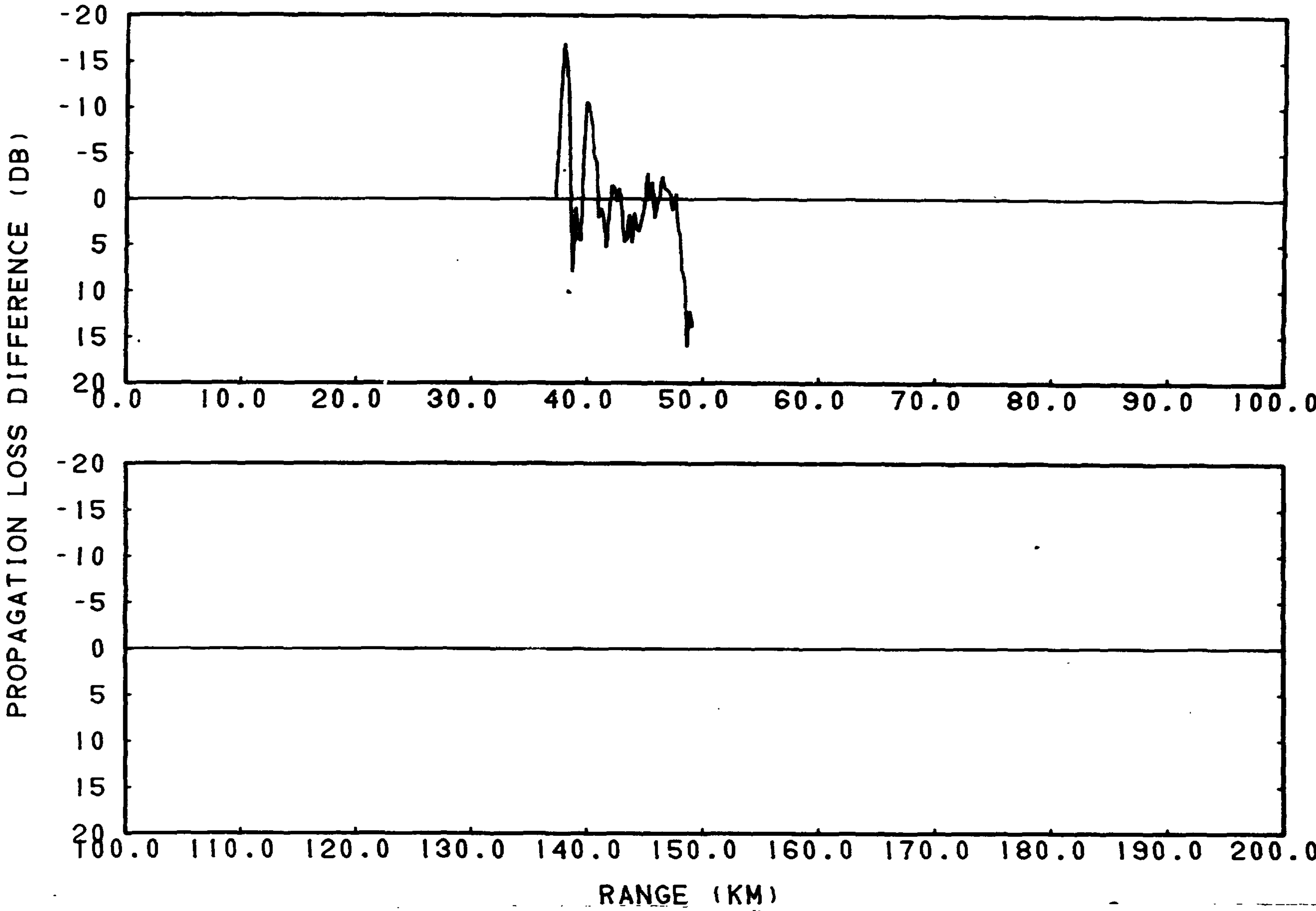
CONFIDENTIAL

(C) Figure IIF-18b. FACT Coherent Station 3 Run 93, Source Depth = 20 Feet, Receiver Depth = 535 Feet



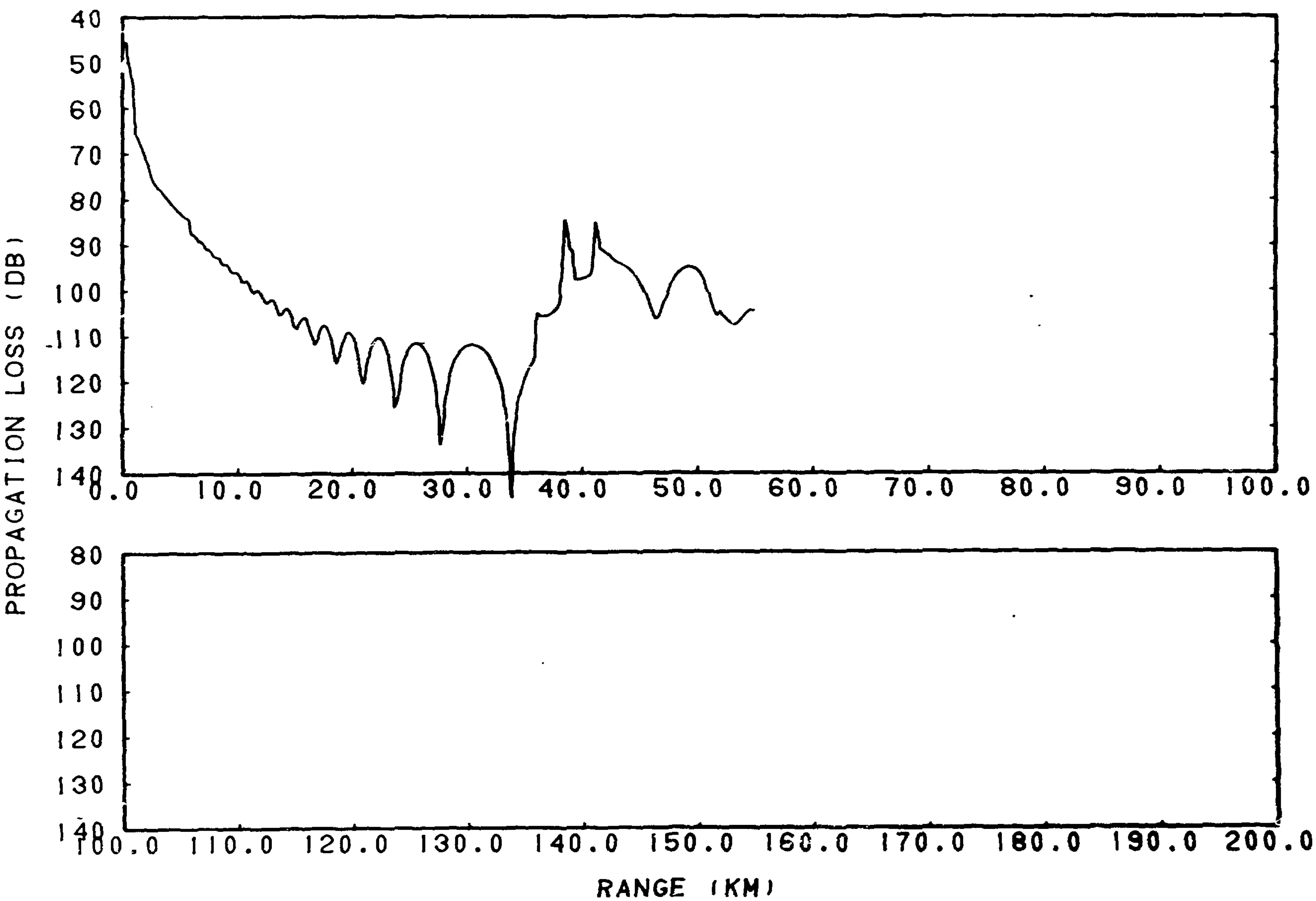
CONFIDENTIAL

(C) Figure IIF-18c. FACT Coherent Station 3 Run 93, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



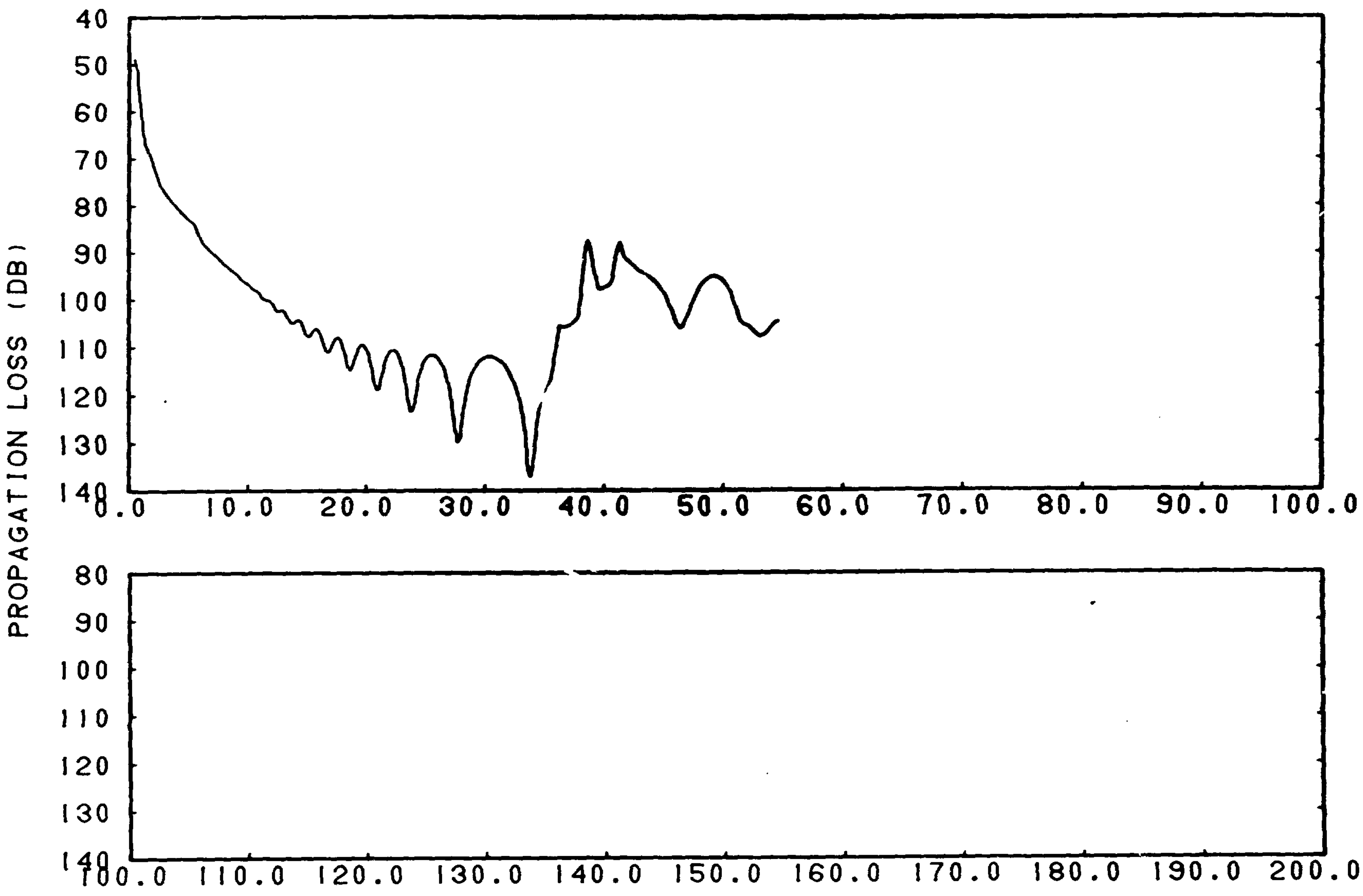
CONFIDENTIAL

(C) Figure IIF-18d. Smoothed FACT Coherent Station 3 Run 93, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Subtracted from Station 3 Run 93, Source Depth = 20 Feet, Receiver Depth = 535 Feet



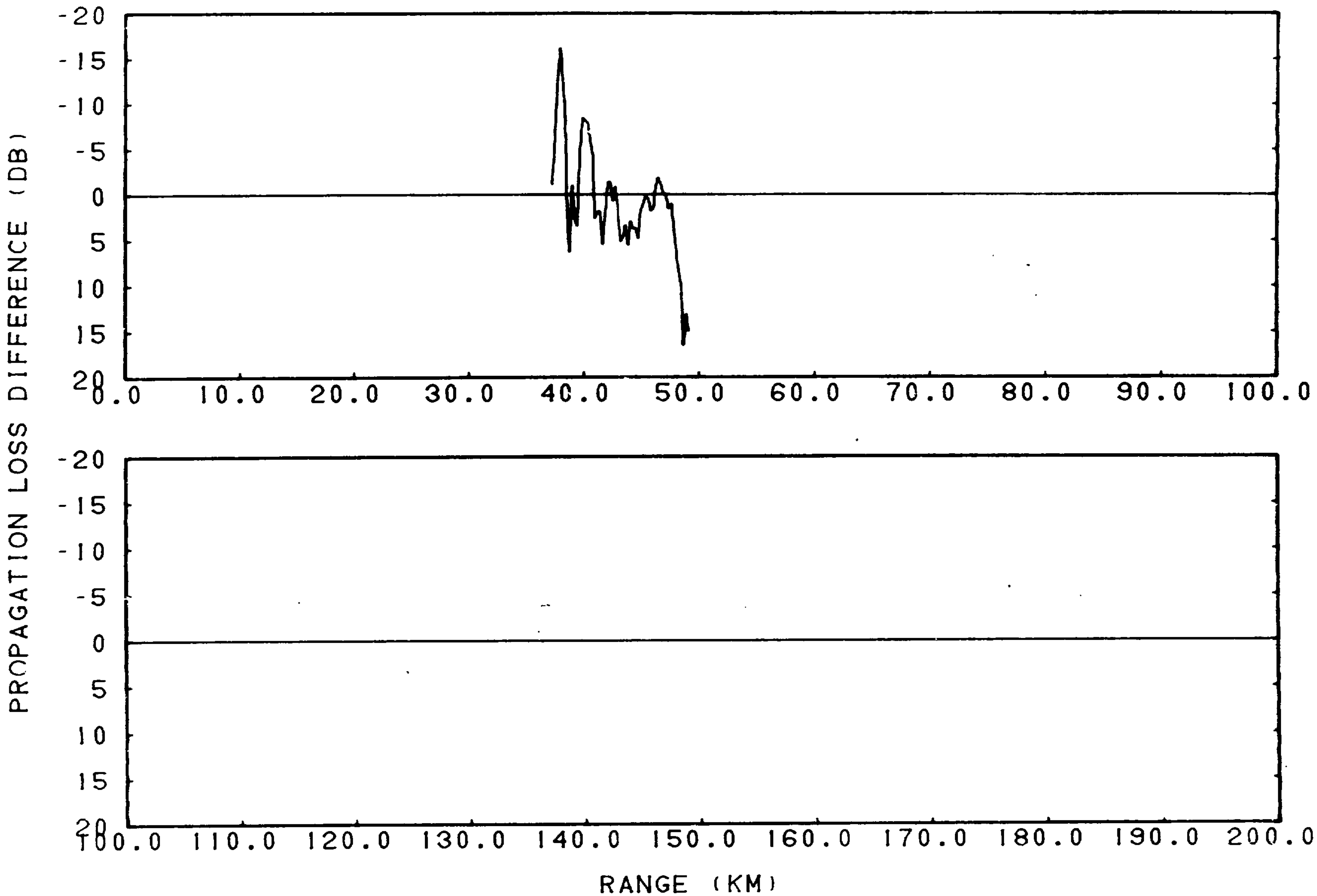
CONFIDENTIAL

(C) Figure IIF-18e. FACT Semi-coherent Station 3 Run 93, Source Depth = 20 Feet, Receiver Depth = 5?5 Feet



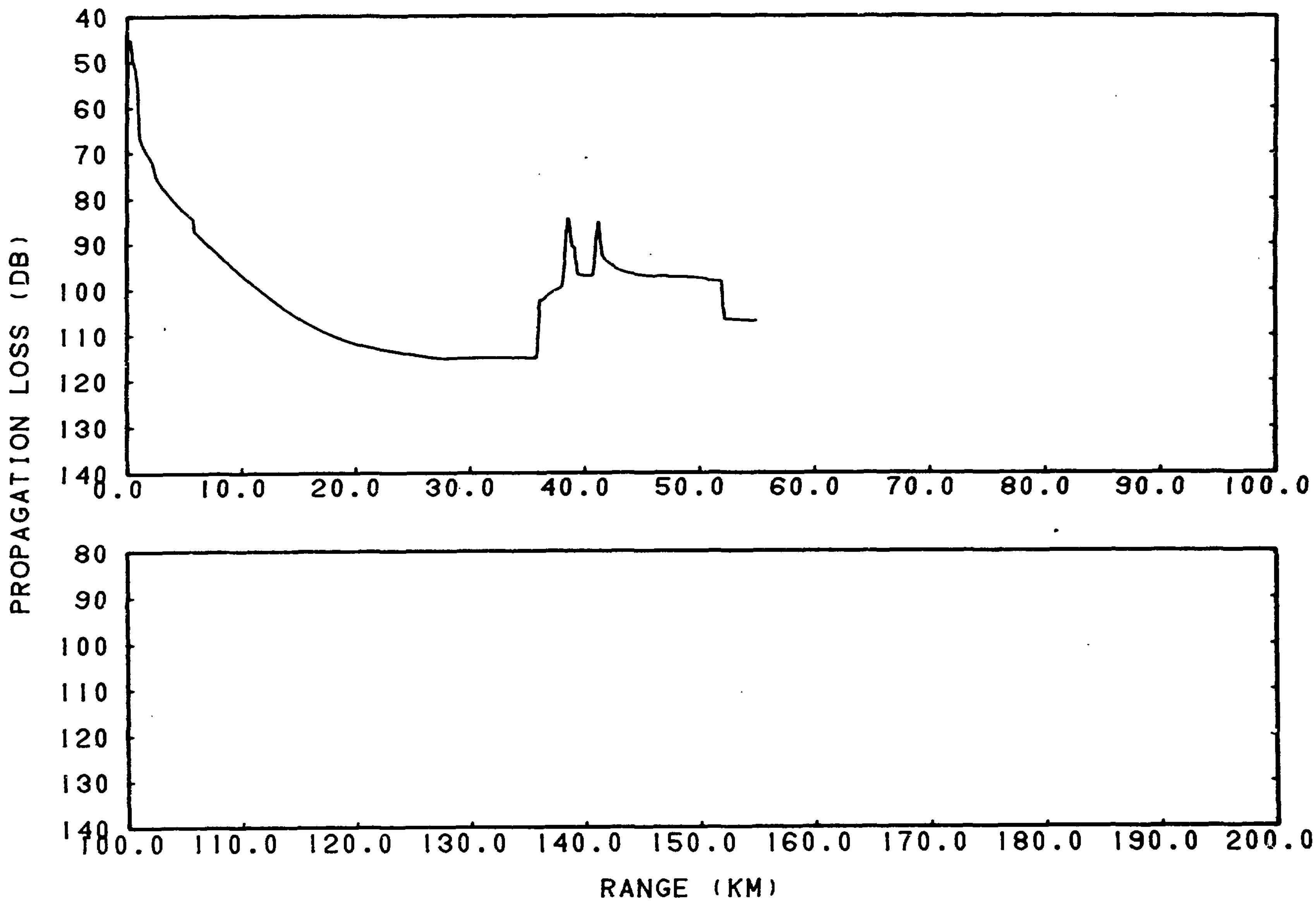
CONFIDENTIAL

(C) Figure IIF-18f. FACT Semi-coherent Station 3 Run 93, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



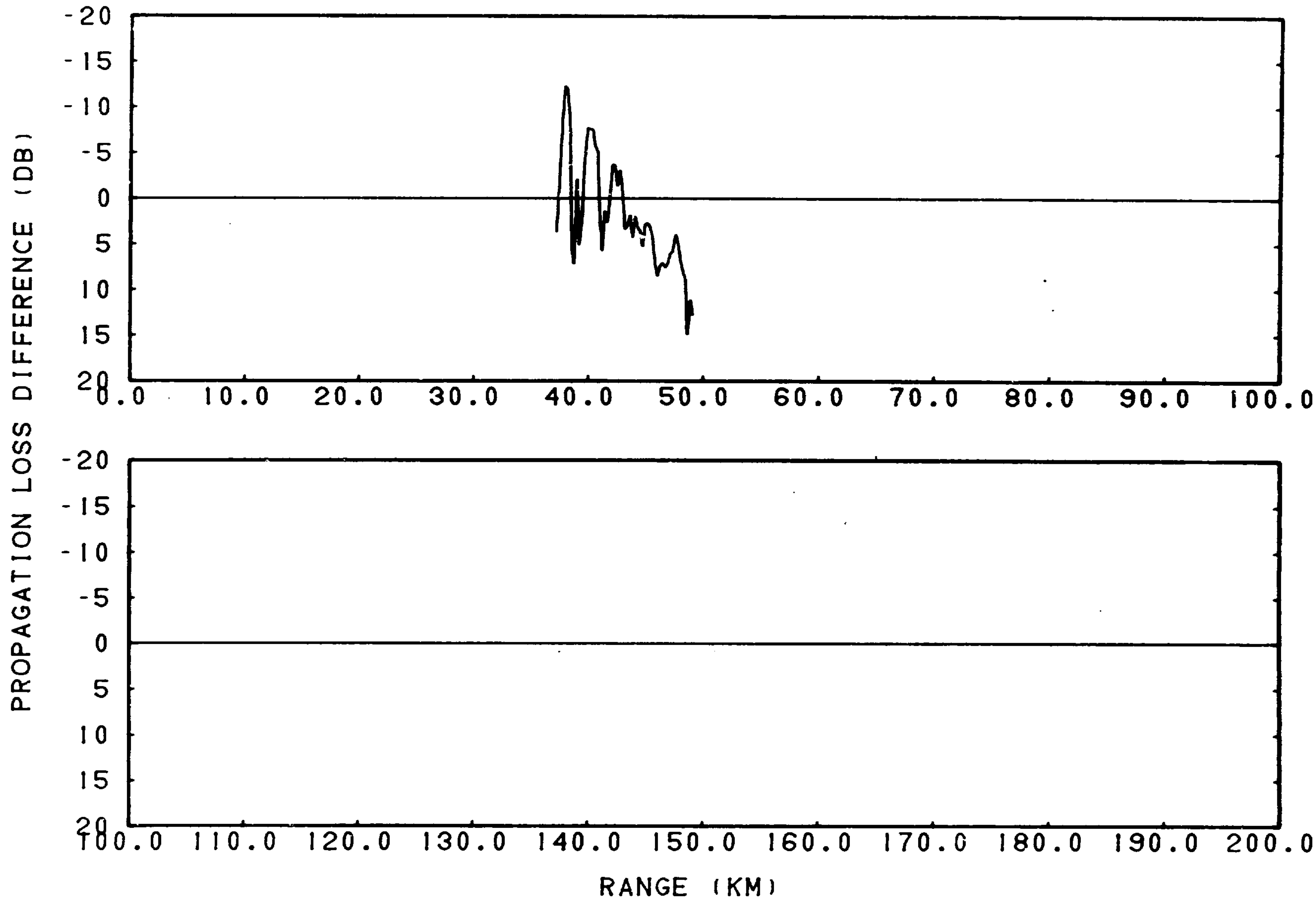
CONFIDENTIAL

(C) Figure IIF-18g. Smoothed FACT Semi-coherent Station 3 Run 93, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Subtracted from Station 3 Run 93, Source Depth = 20 Feet, Receiver Depth = 535 Feet



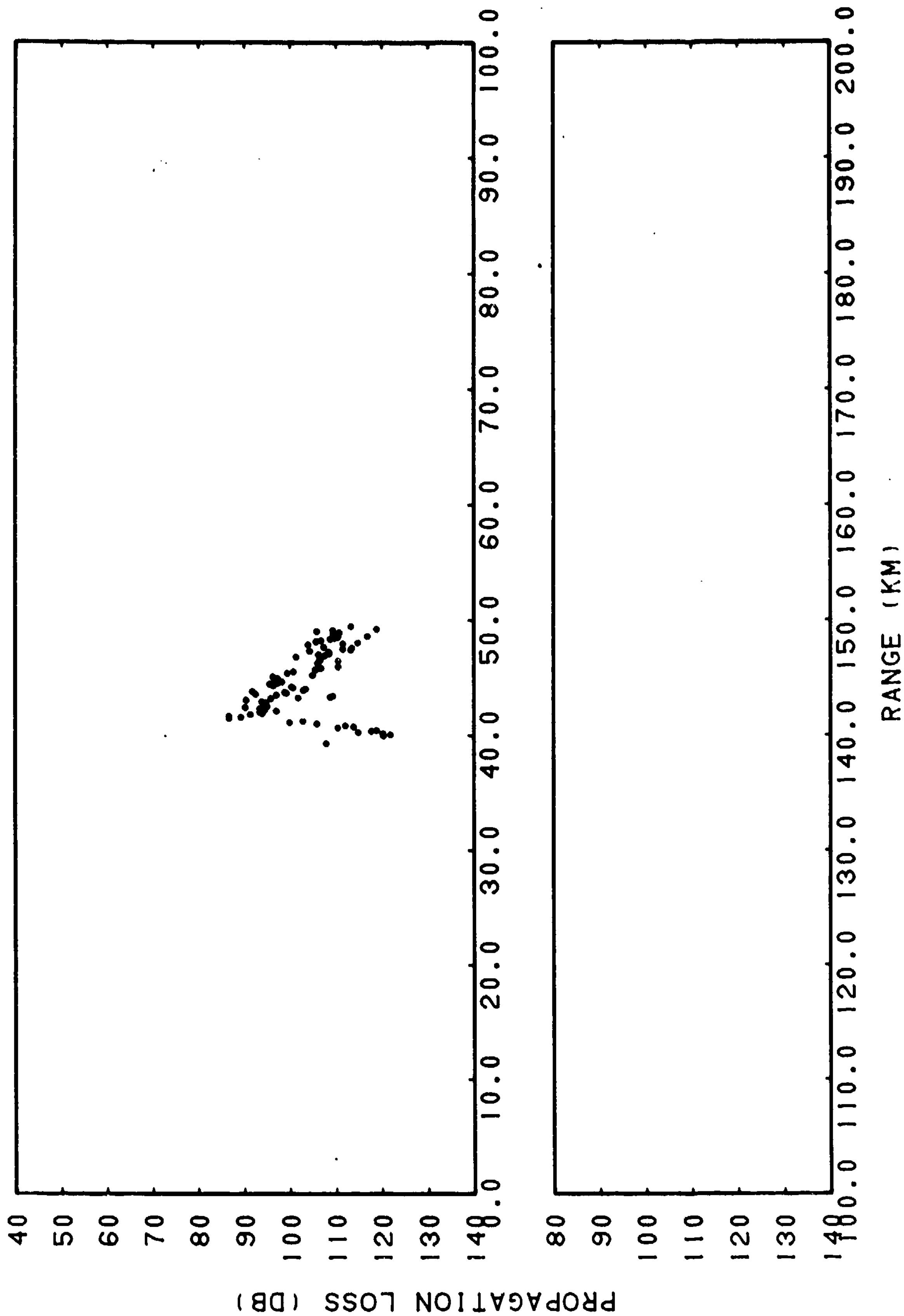
CONFIDENTIAL

(C) Figure IIF-18h. FACT Incoherent Station 3, Run 93, Source Depth = 20 Feet, Receiver Depth = 535 Feet



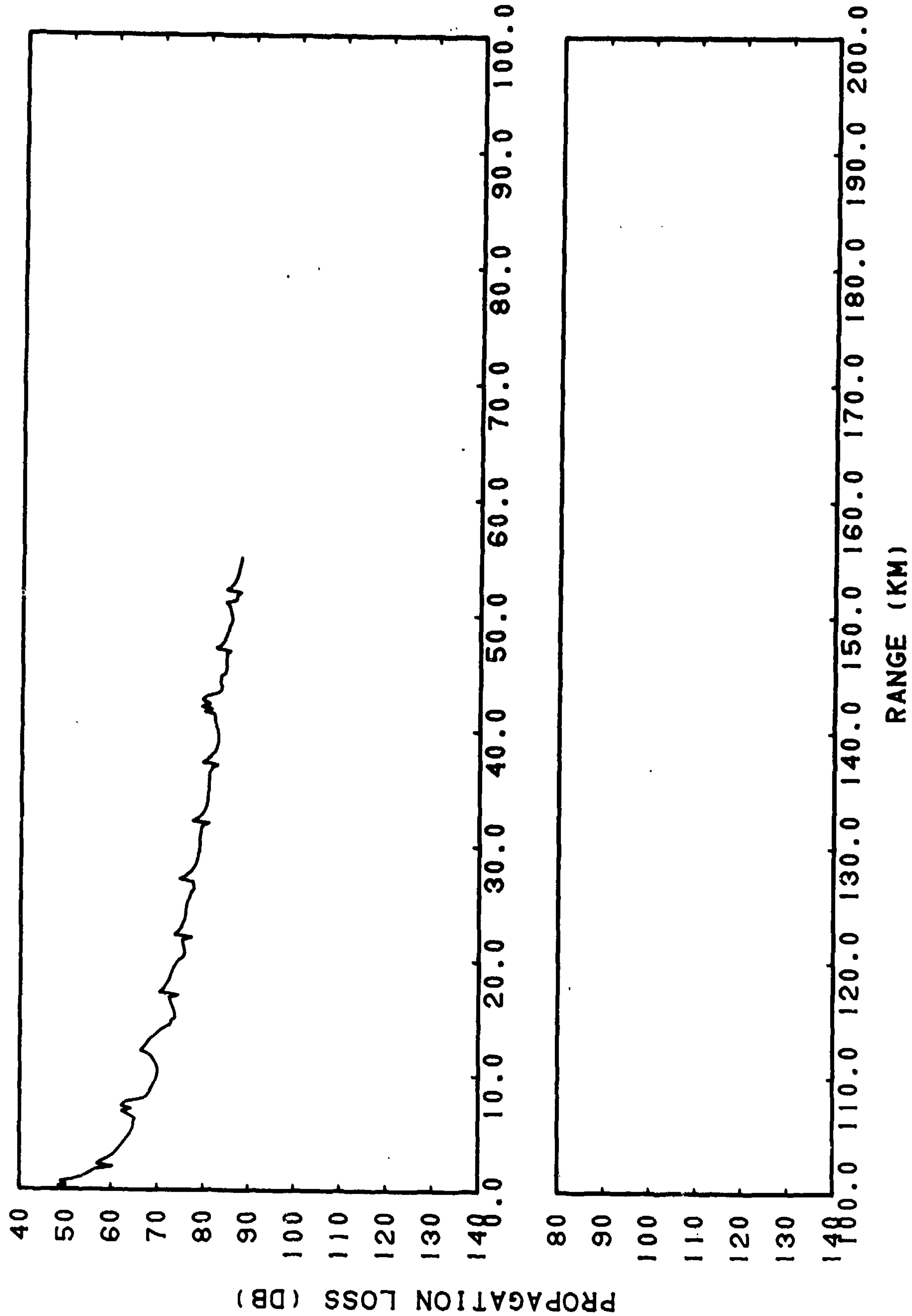
CONFIDENTIAL

(C) Figure IIF-18i. FACT Incoherent Station 3 Run 93, Source Depth = 20 Feet, Receiver Depth = 535 Feet, Subtracted from Station 3 Run 93, Source Depth = 20 Feet, Receiver Depth = 535 Feet



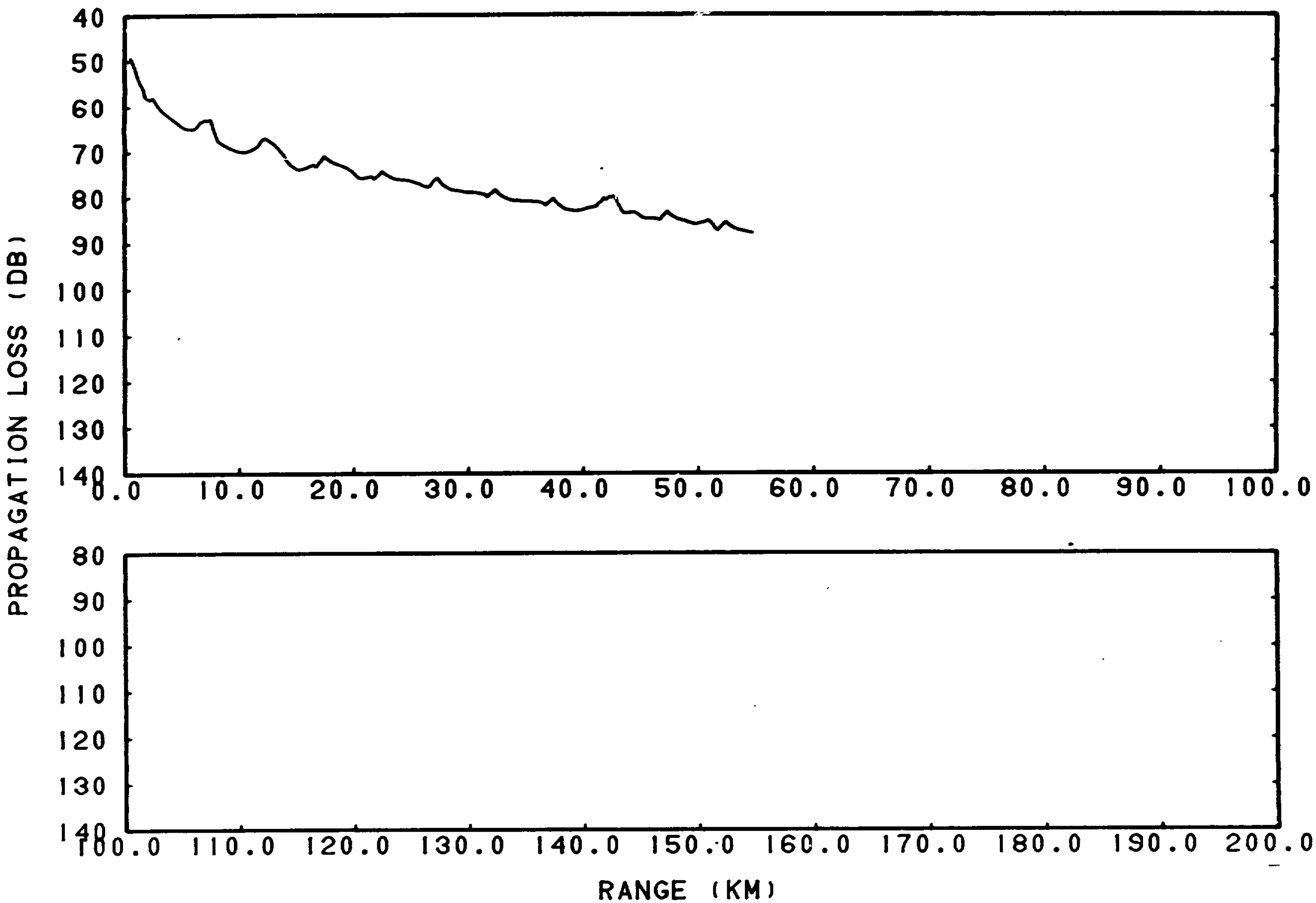
CONFIDENTIAL

(C) Figure IIF-19a. Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



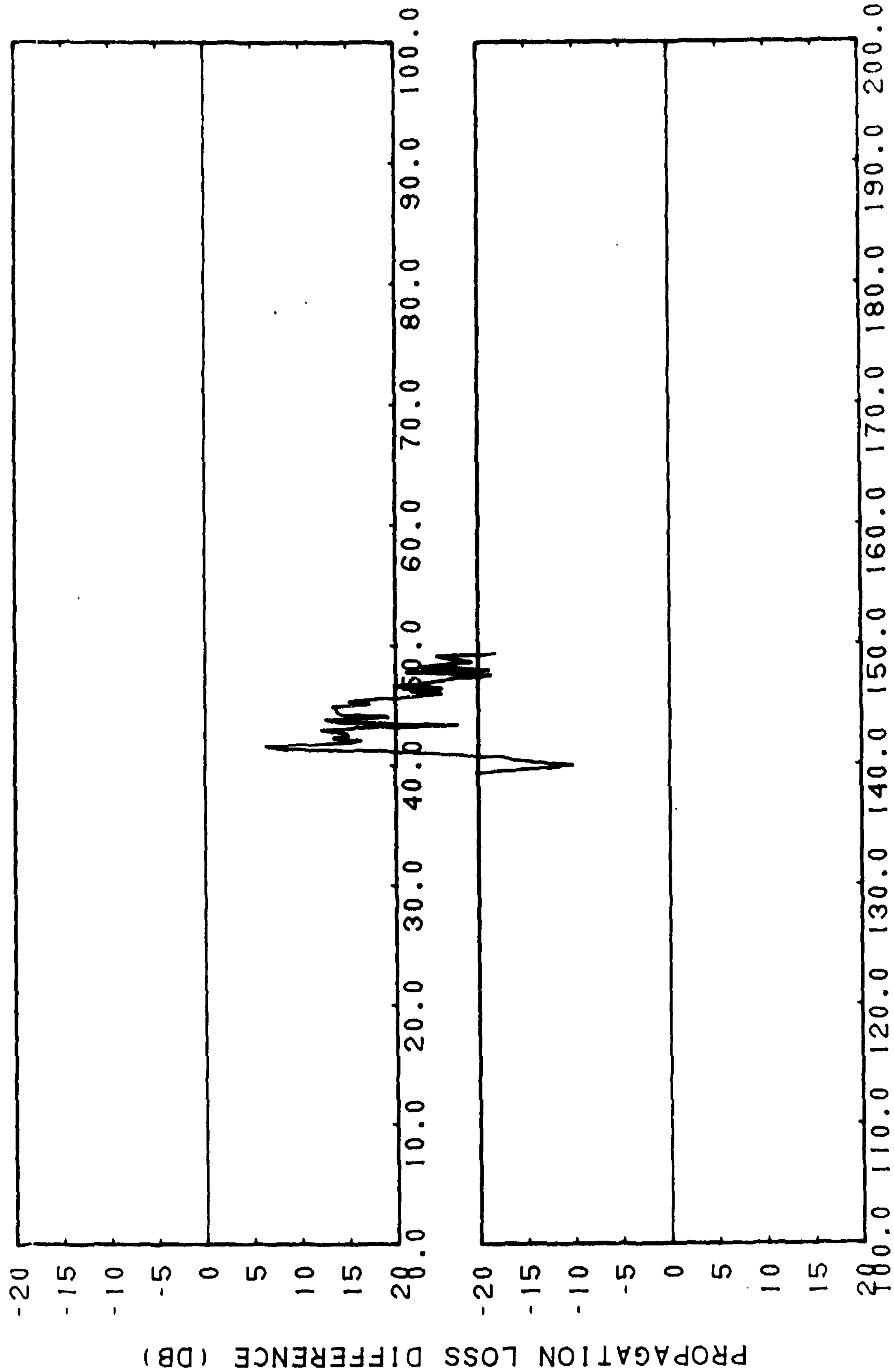
CONFIDENTIAL

(C) Figure IIIF-19b. FACT Coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



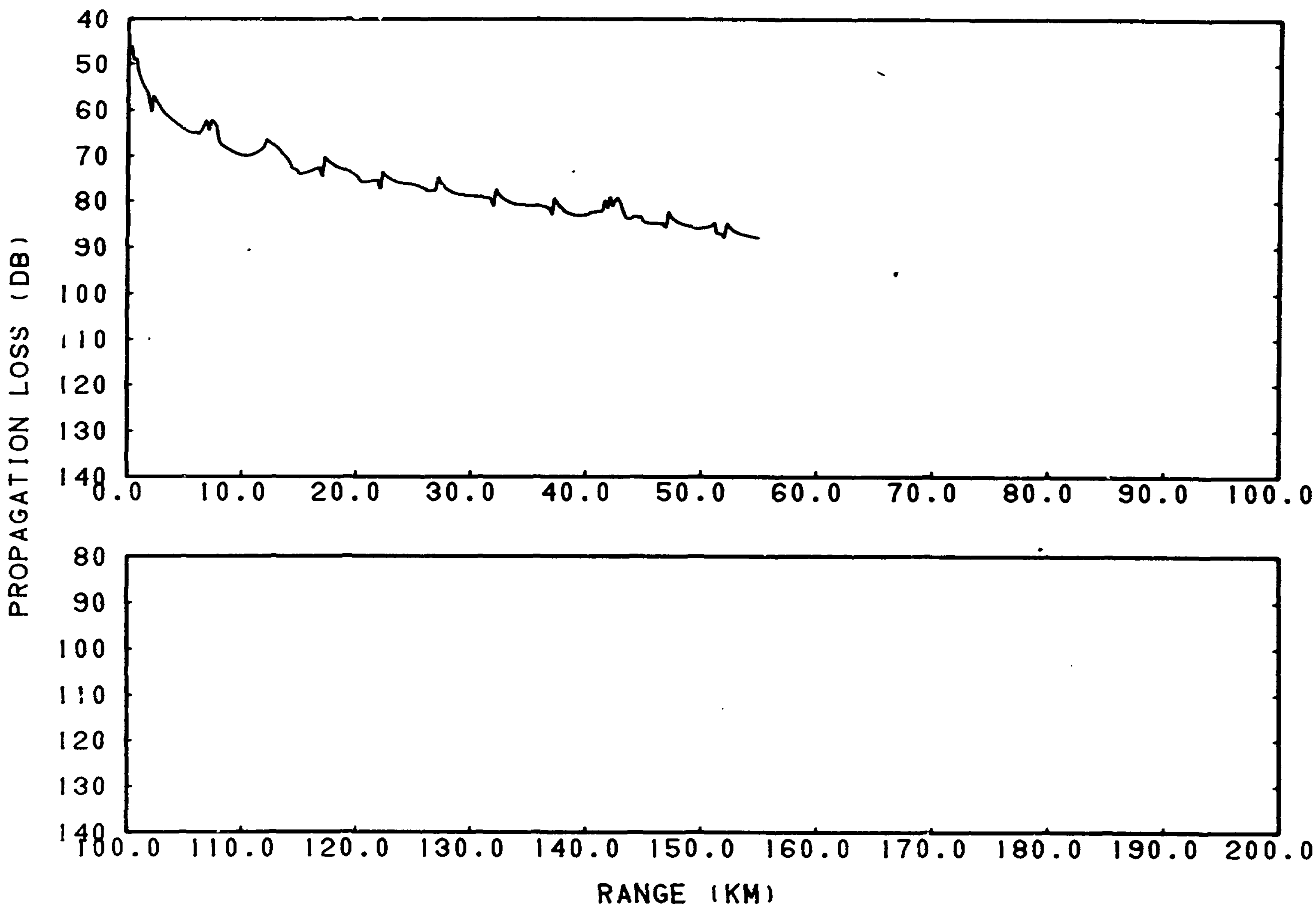
CONFIDENTIAL

(C) Figure IIF-19c. FACT Coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



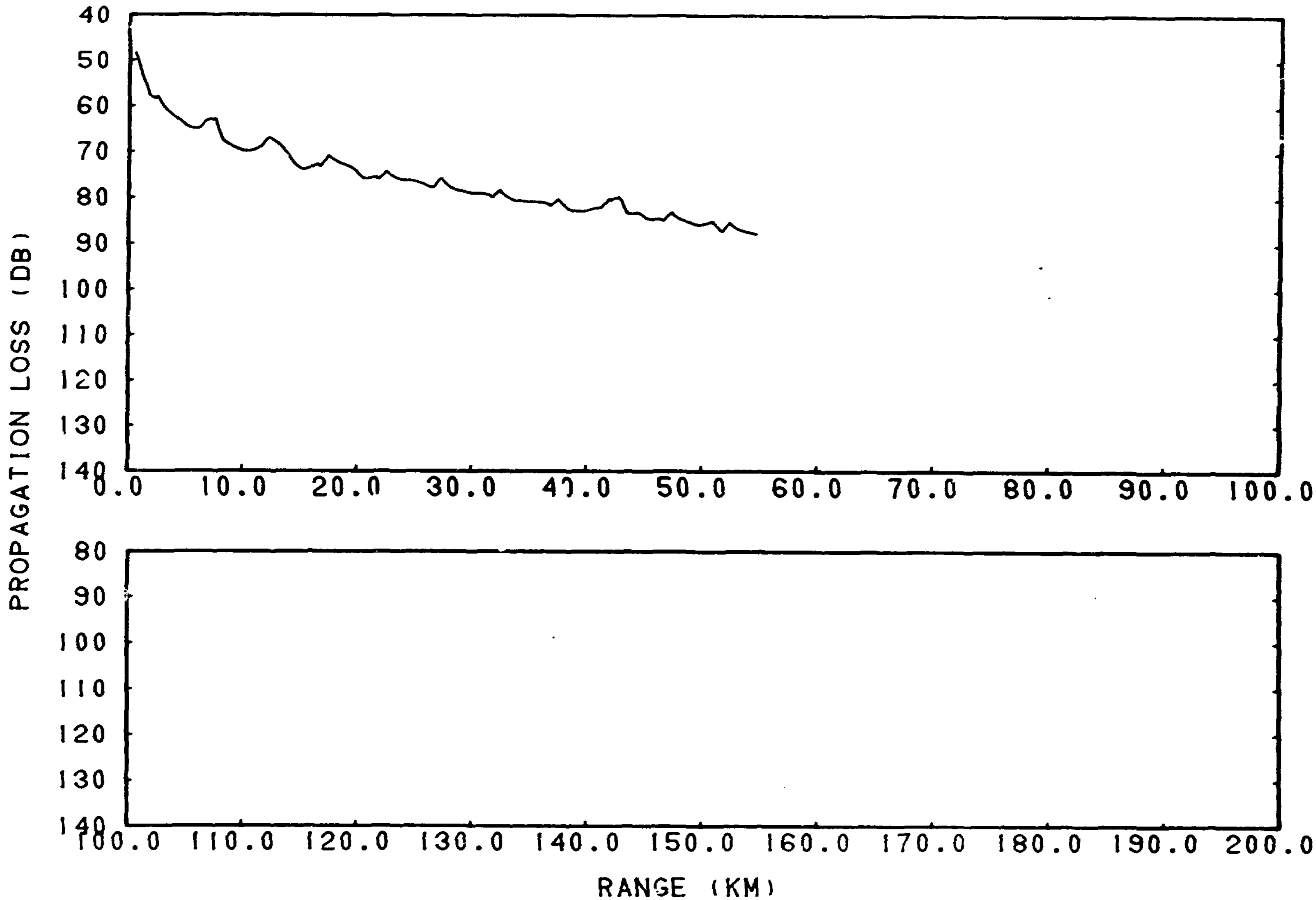
CONFIDENTIAL

(C) Figure IIF-19d. Smoothed FACT Coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



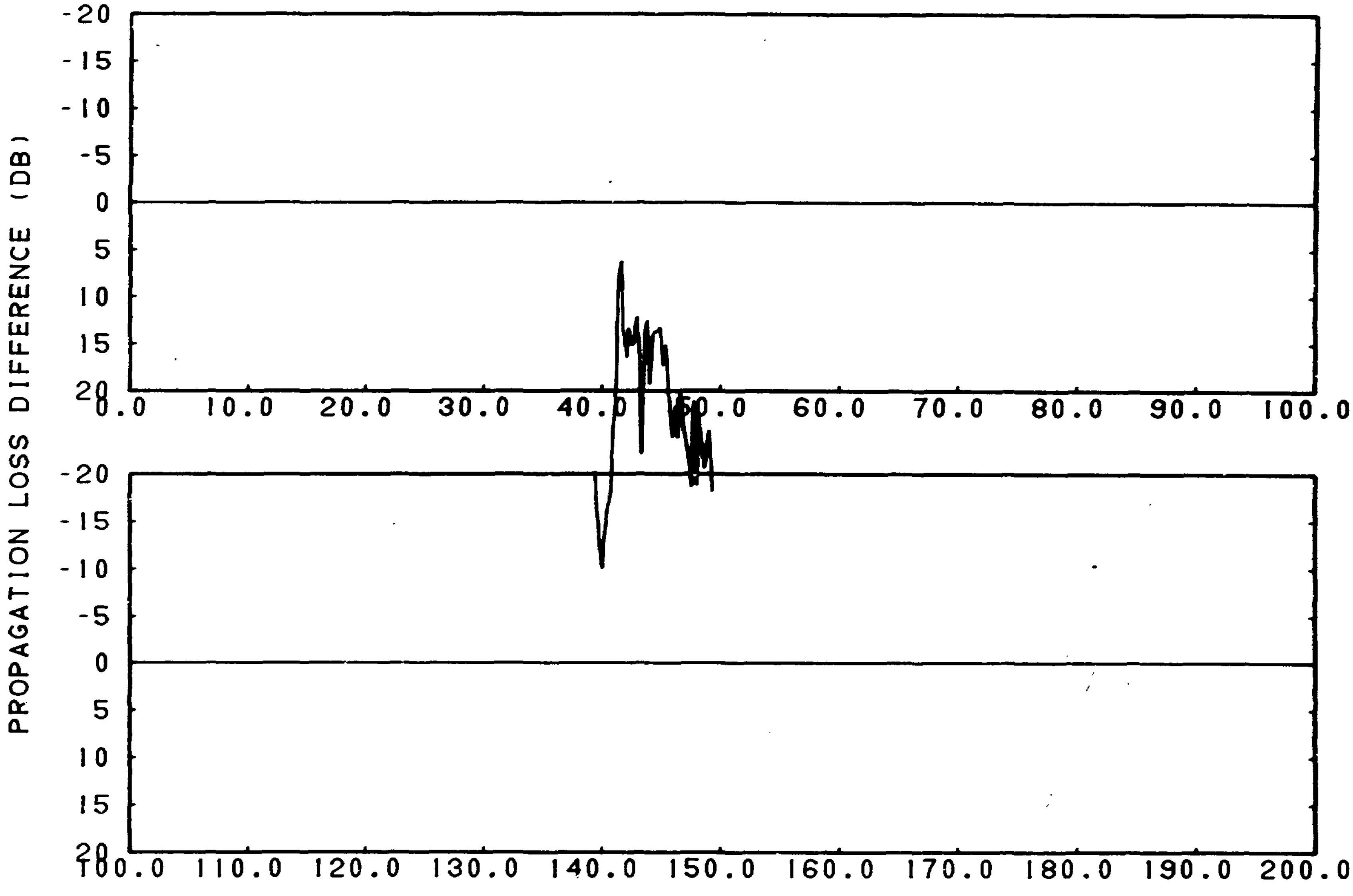
CONFIDENTIAL

(C) Figure IIF-19e. FACT Semi-coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



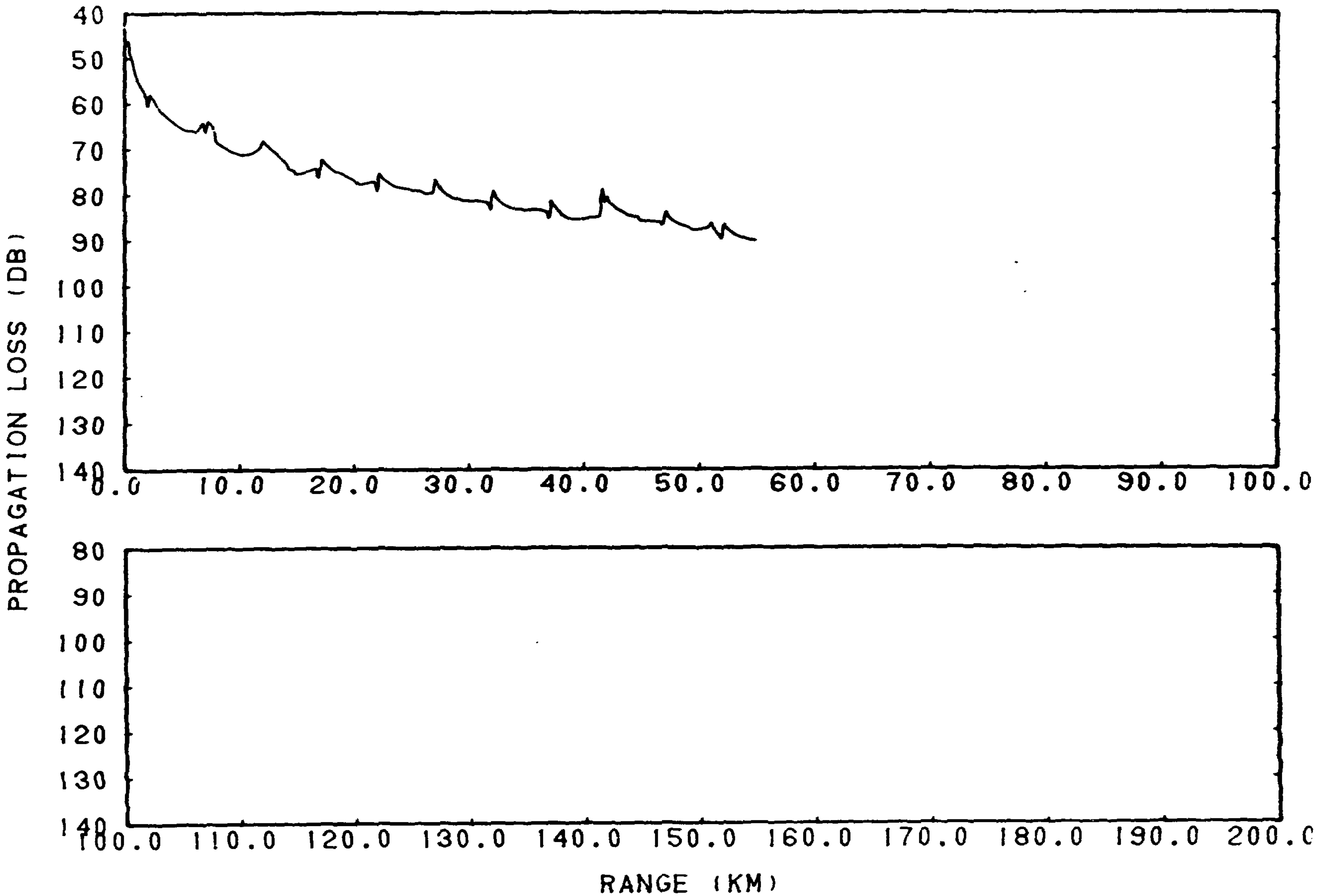
CONFIDENTIAL

(C) Figure IIF-19f. FACT Semi-coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Sliding Averages *of 3 Points (0.43 Kilometer)*



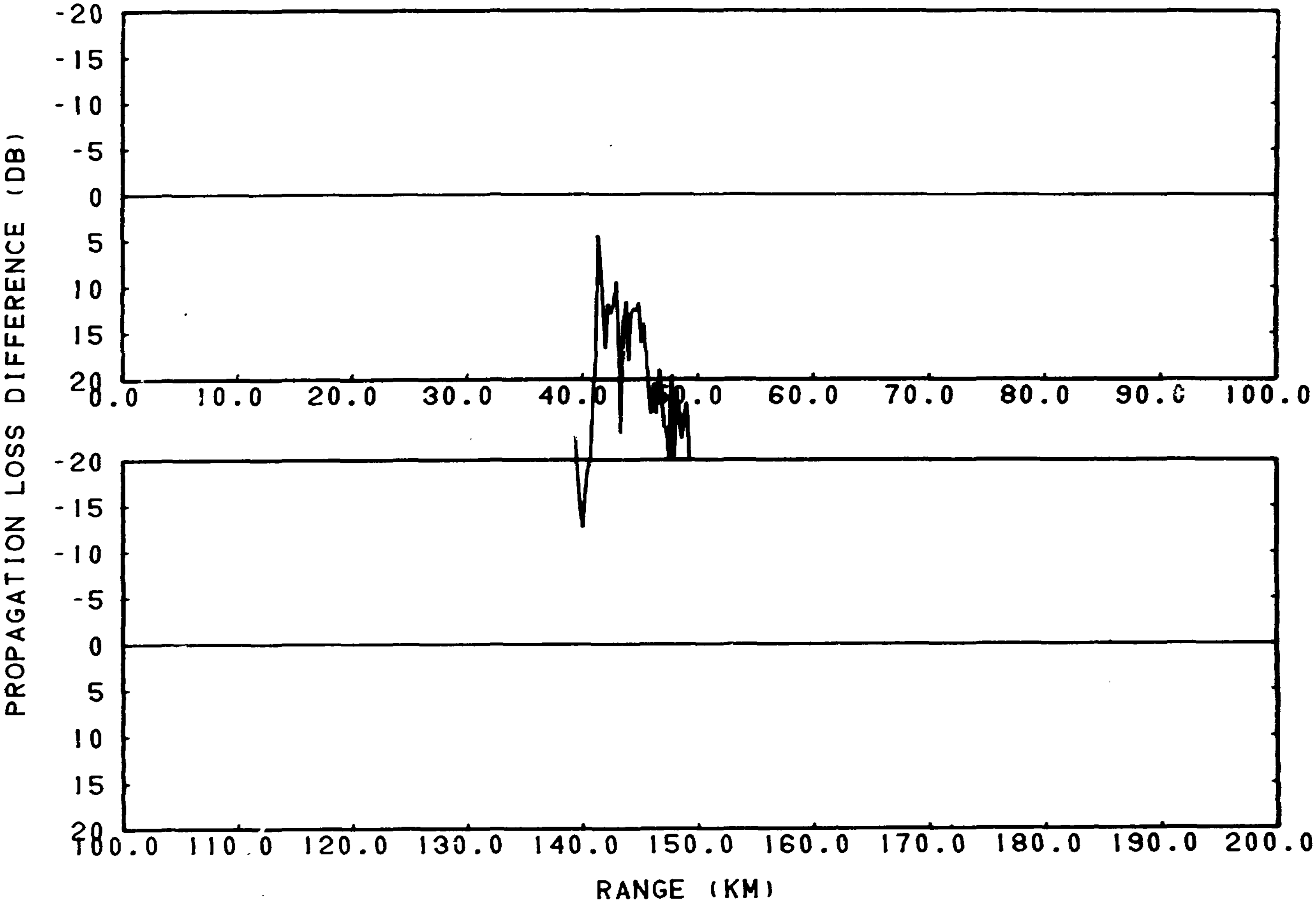
CONFIDENTIAL

(C) Figure IIF-19g. Smoothed FACT Semi-coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



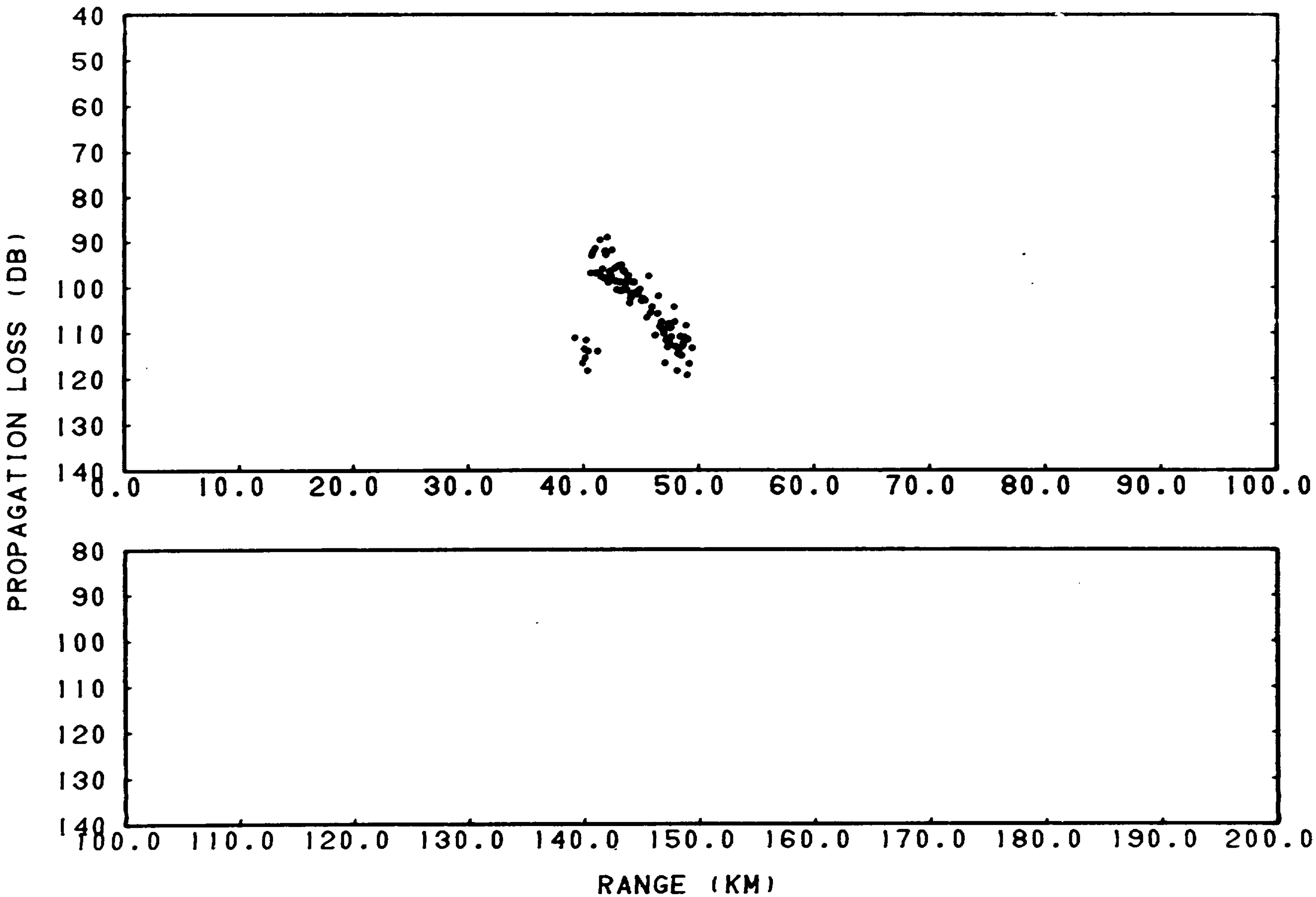
CONFIDENTIAL

(C) Figure IIF-19h. FACT Incoherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



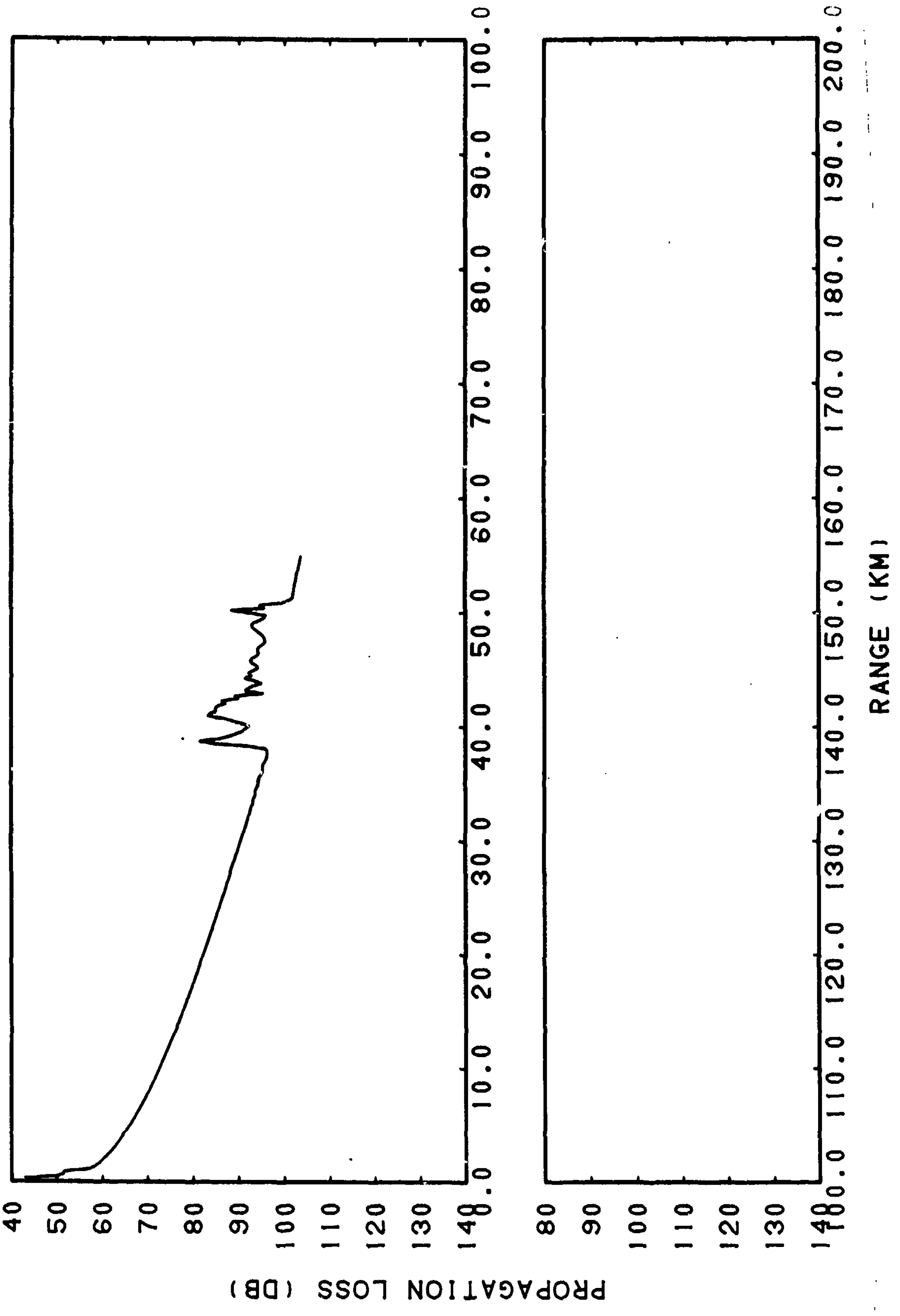
CONFIDENTIAL

(C) Figure IIF-19i. FACT Incoherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet, Subtracted from Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 60 Feet



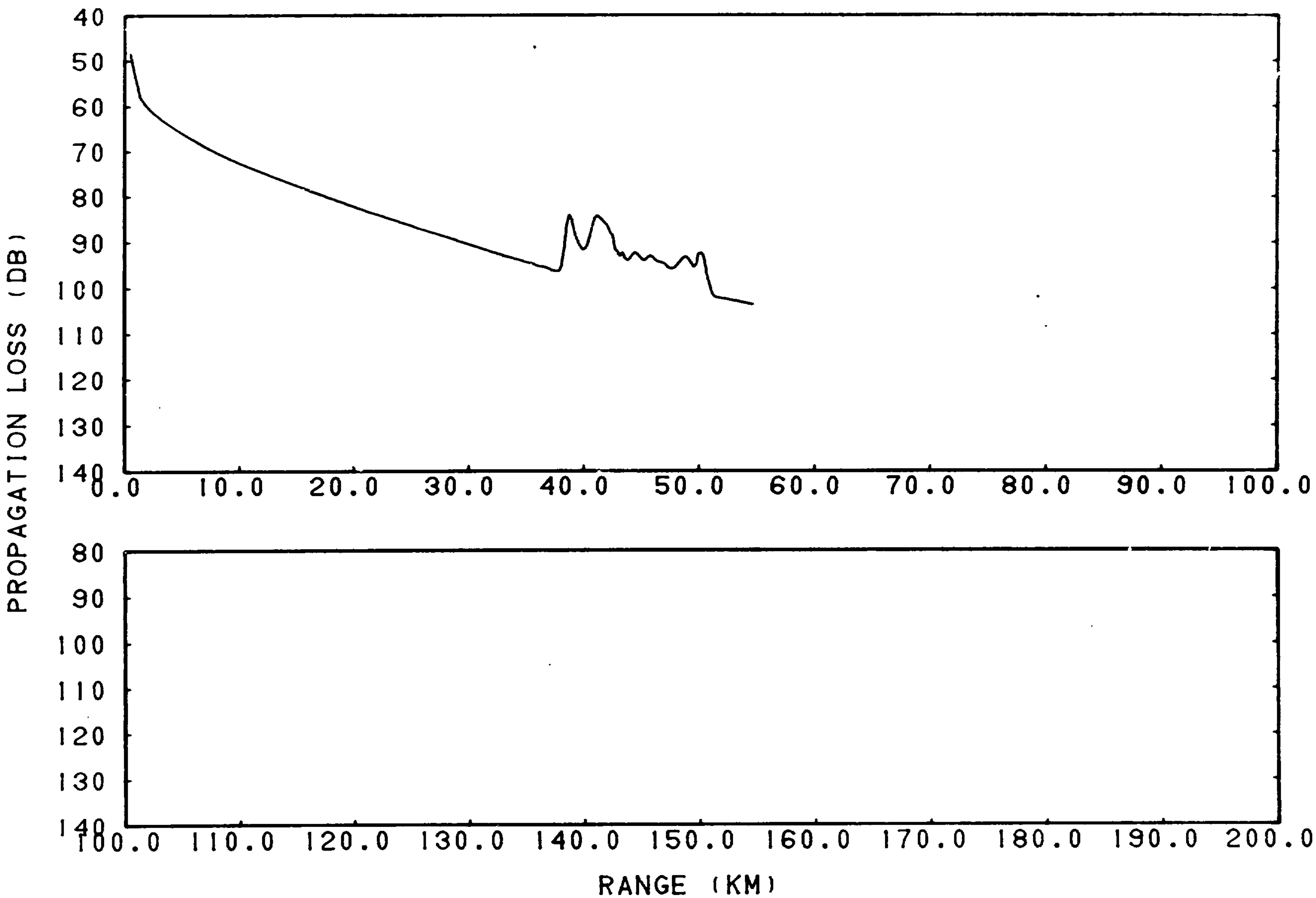
CONFIDENTIAL

(C) Figure IIF-20a. Station 5 Run 43, Scurce Depth = 20 Feet, Receiver Depth = 260 Feet



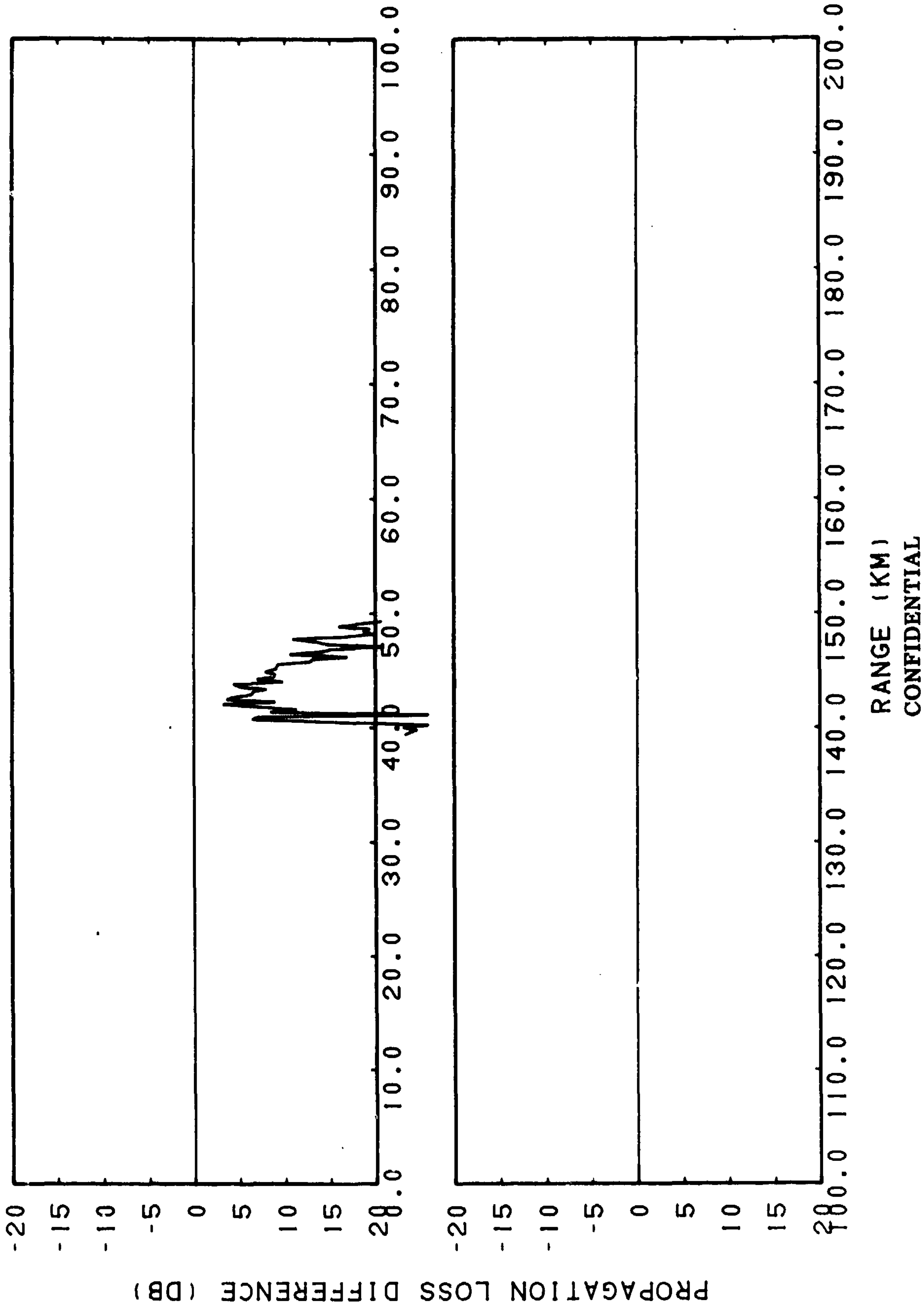
CONFIDENTIAL

(C) Figure IIF-20b. FACT Coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



CONFIDENTIAL

(C) Figure IIF-20c. FACT Coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



CONFIDENTIAL

(C) Figure IIF-20d. Smoothed FACT Coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Subtracted from Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet

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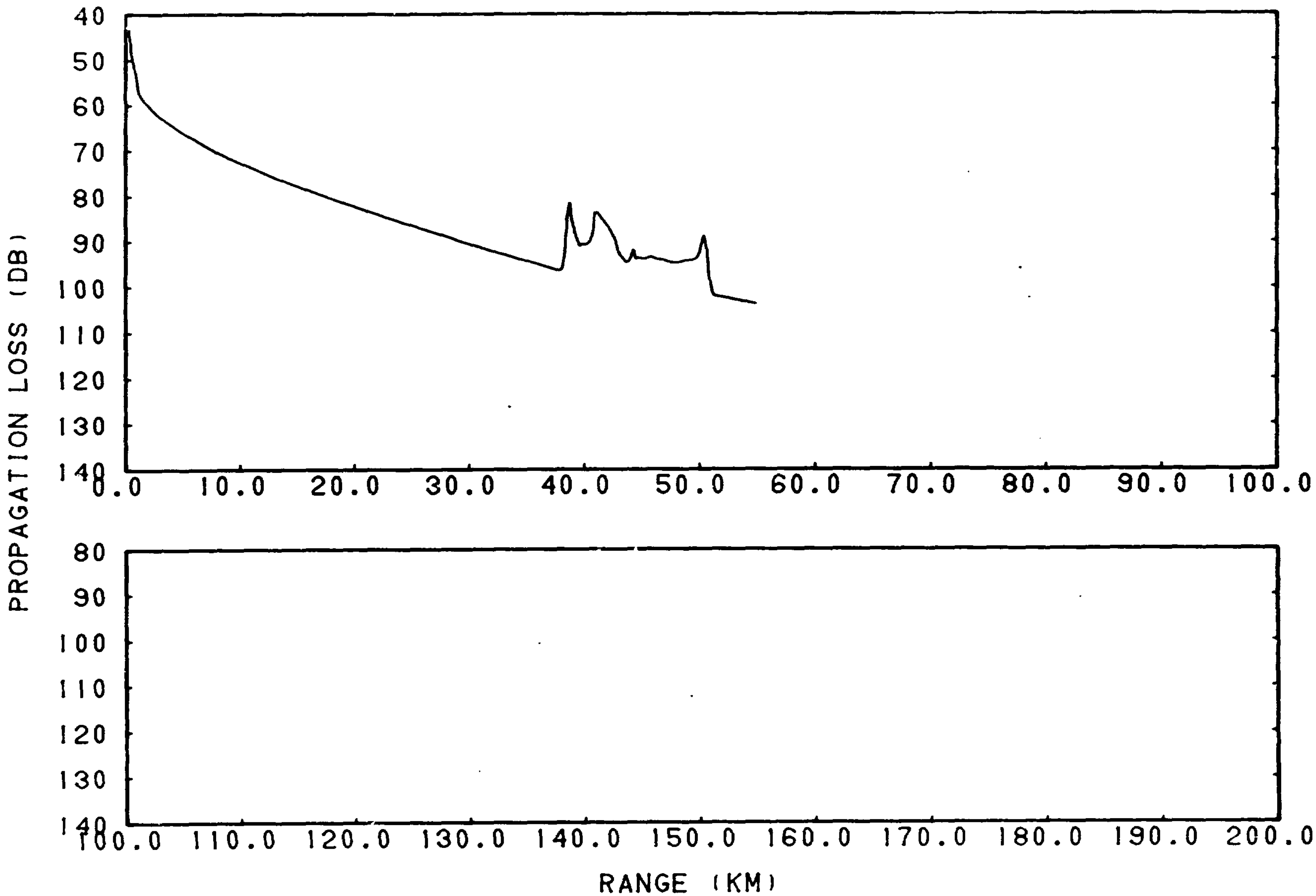
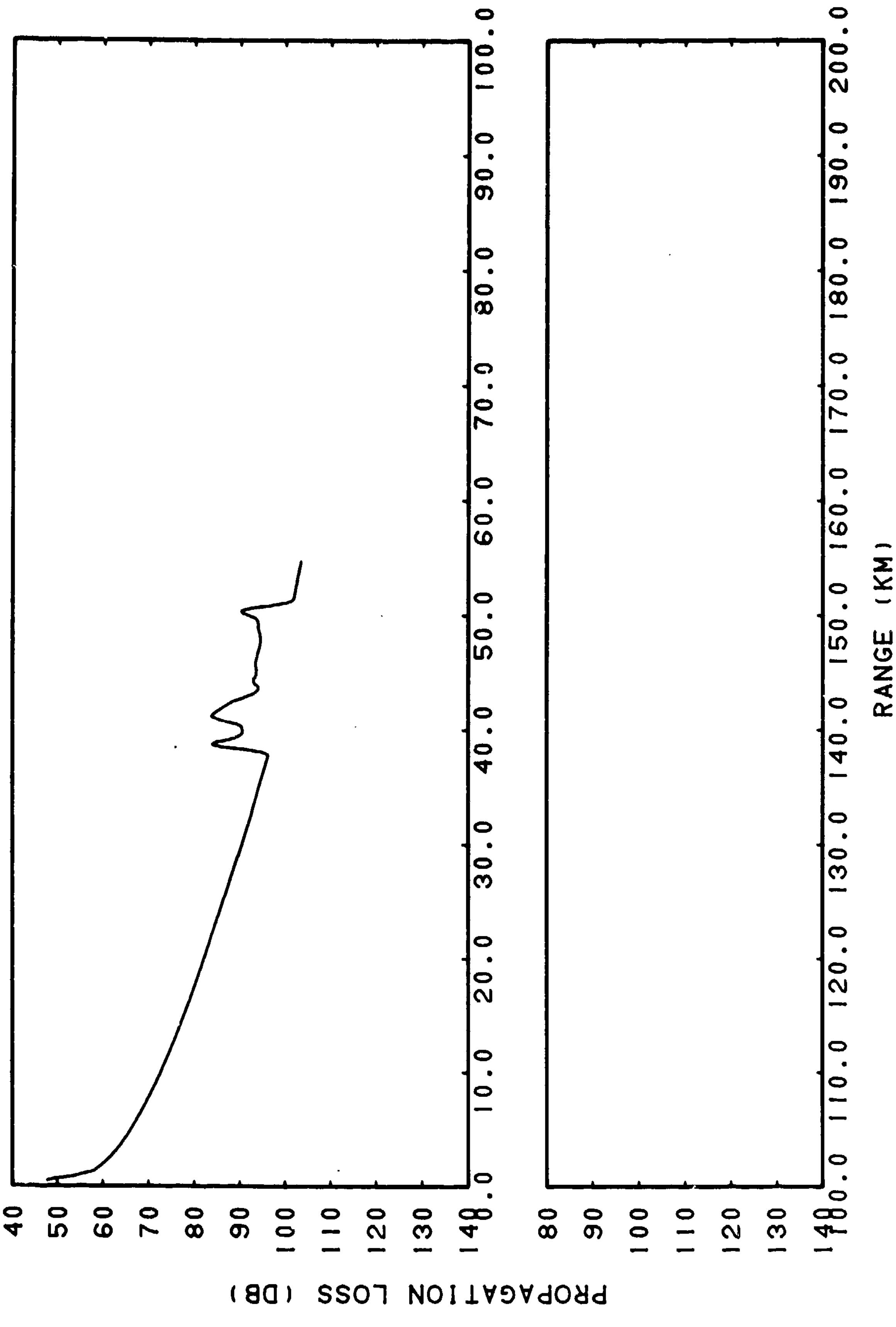


CONFIDENTIAL

(C) Figure IIF-20e. FACT Semi-coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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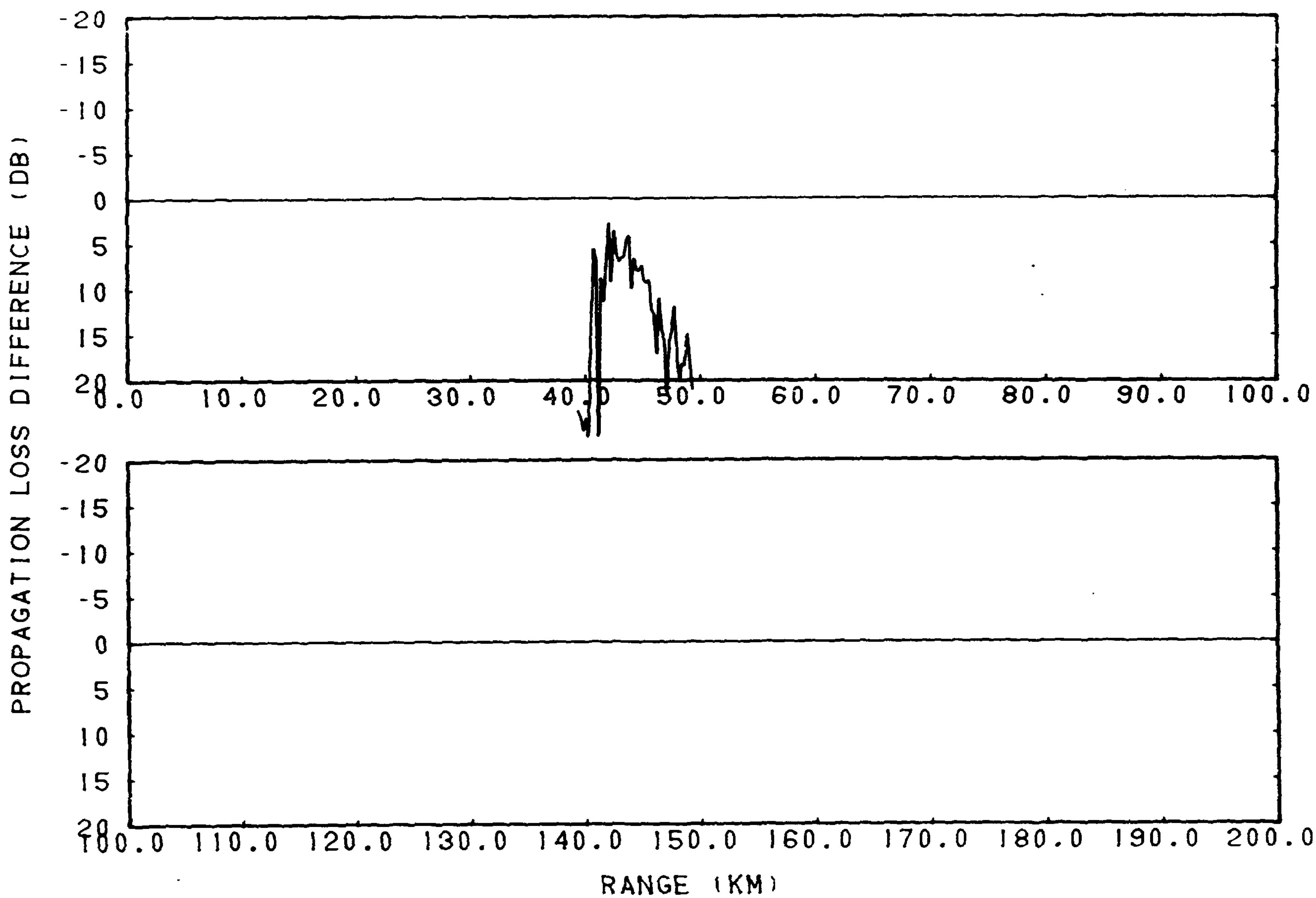
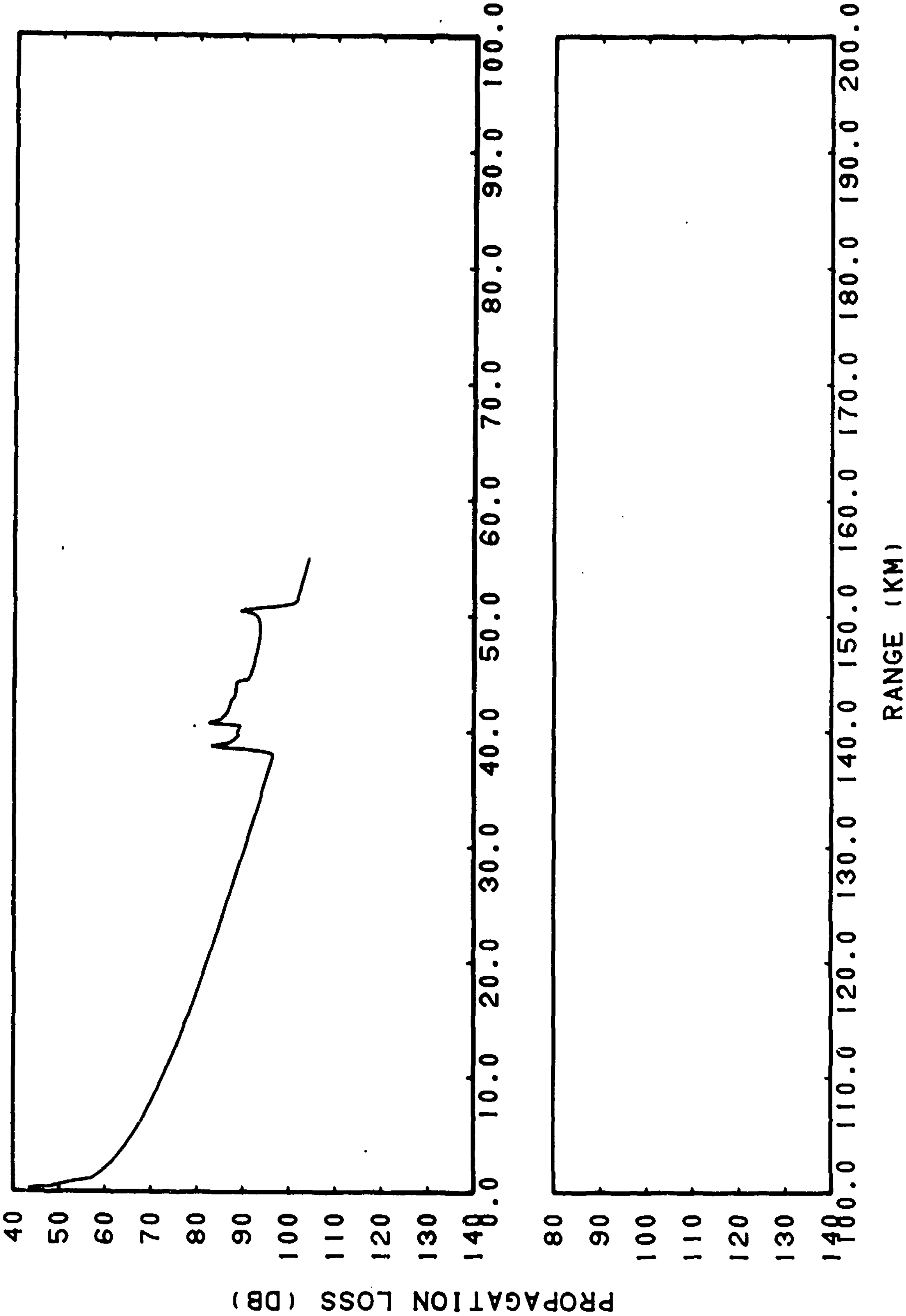
(C) Figure IIF-20f. FACT Semi-coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



CONFIDENTIAL

(C) Figure IIF-20g. Smoothed FACT Semi-coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Subtracted from Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



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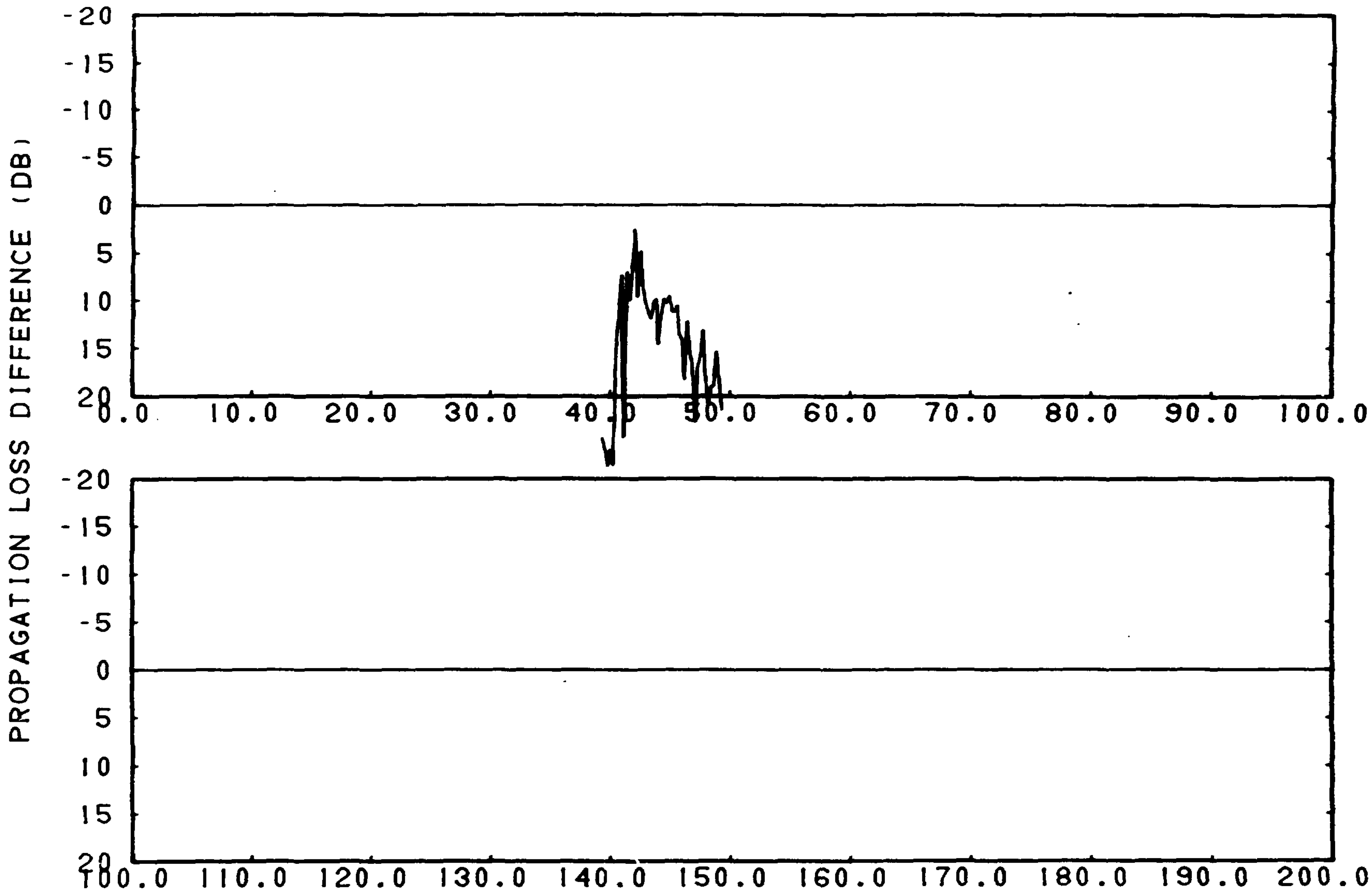
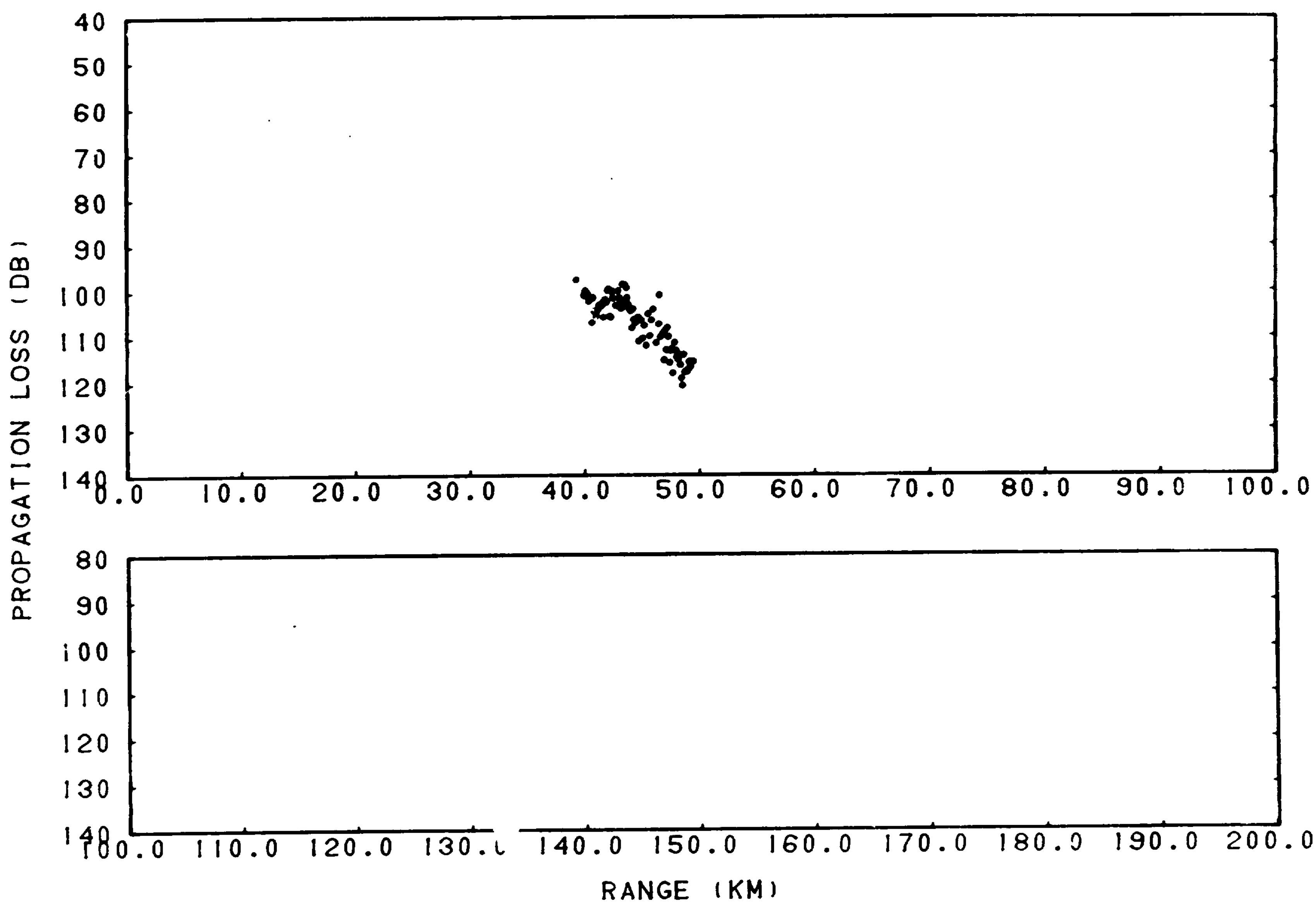
(C) Figure IIF-20h. FACT Incoherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



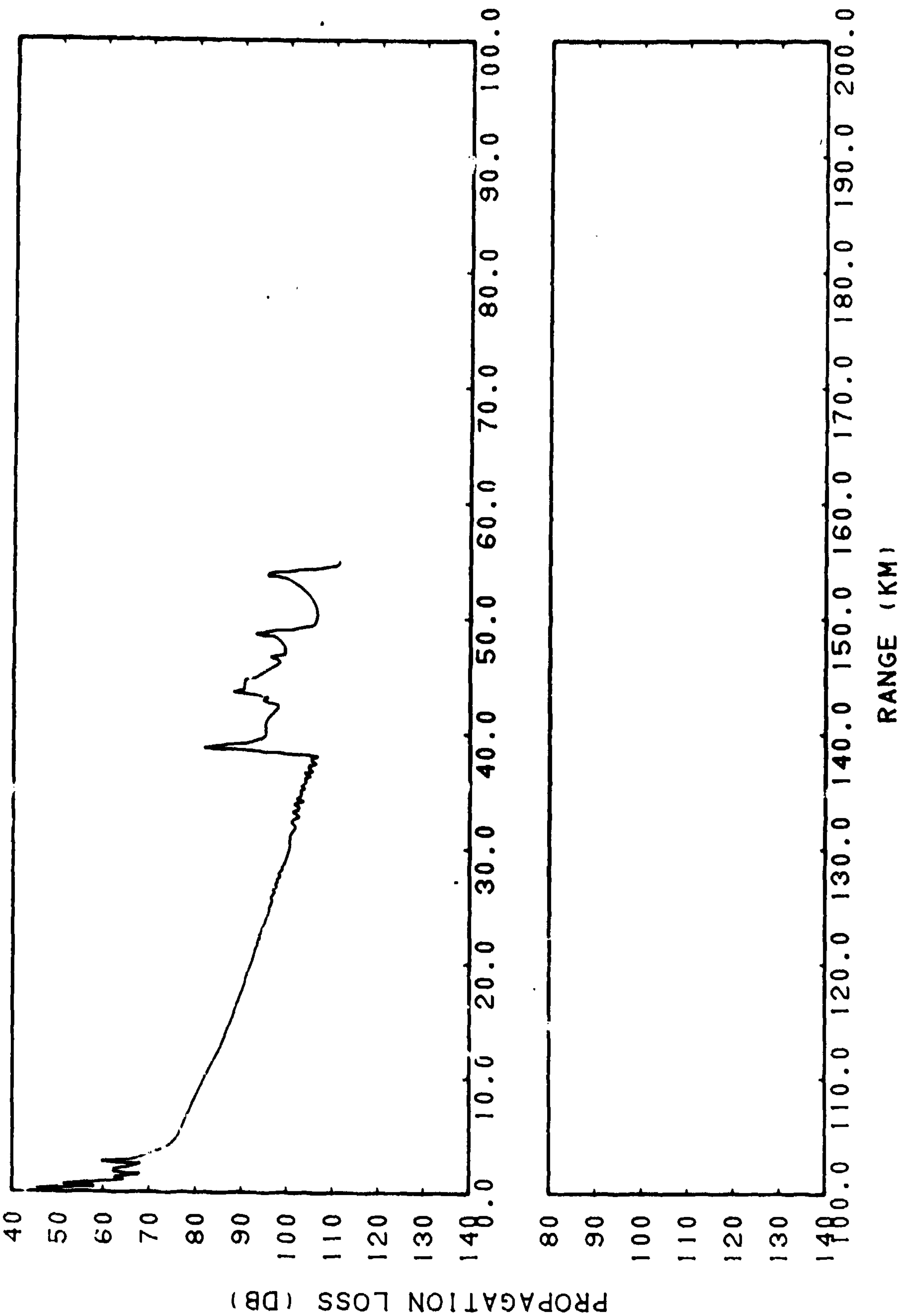
CONFIDENTIAL

(C) Figure IIF-20i. FACT Incoherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet, Subtracted from Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 260 Feet



CONFIDENTIAL

(C) Figure IIF-21a. Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 1000 Feet



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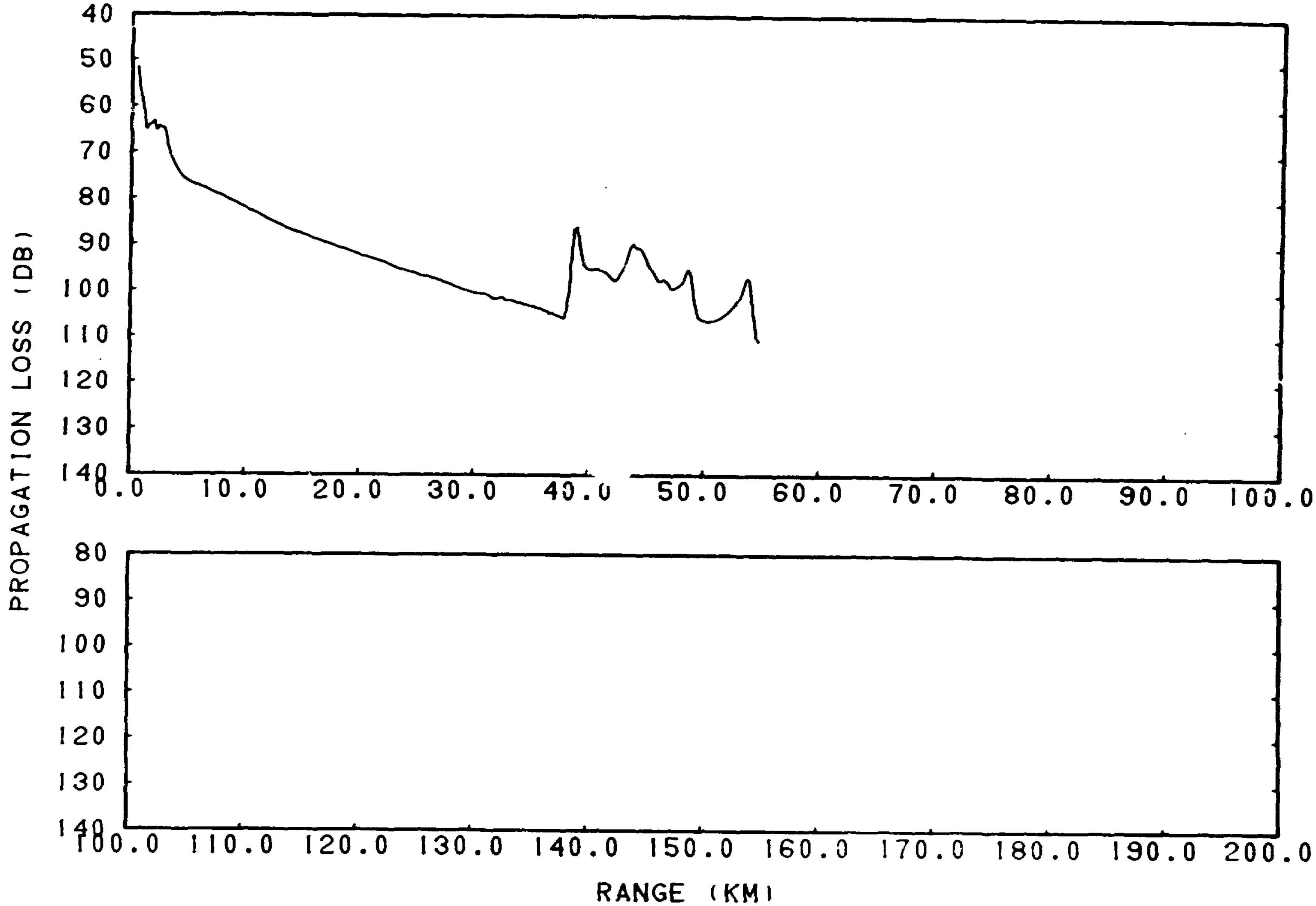
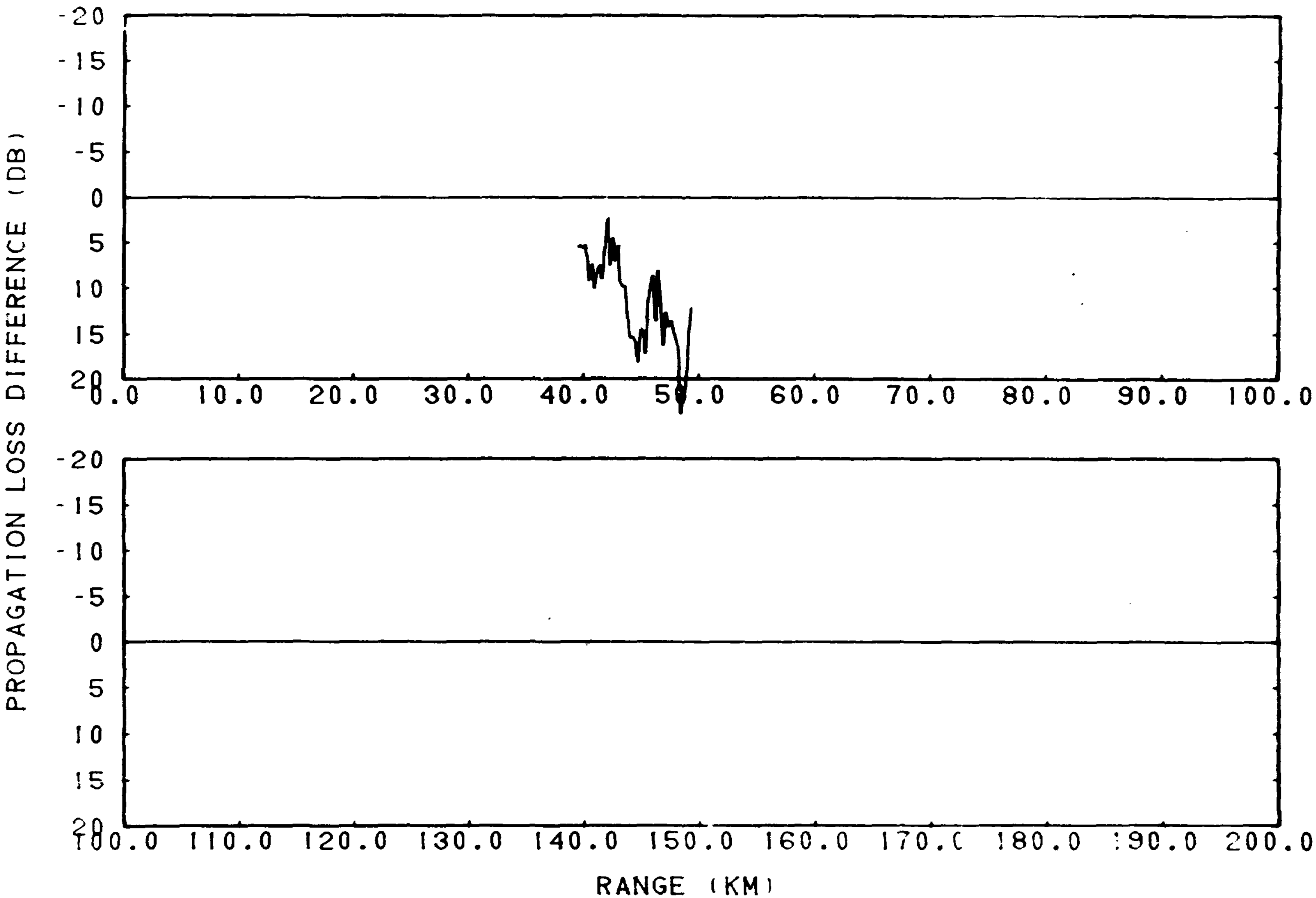
(C) Figure IIF-21b. FACT Coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 1000 Feet



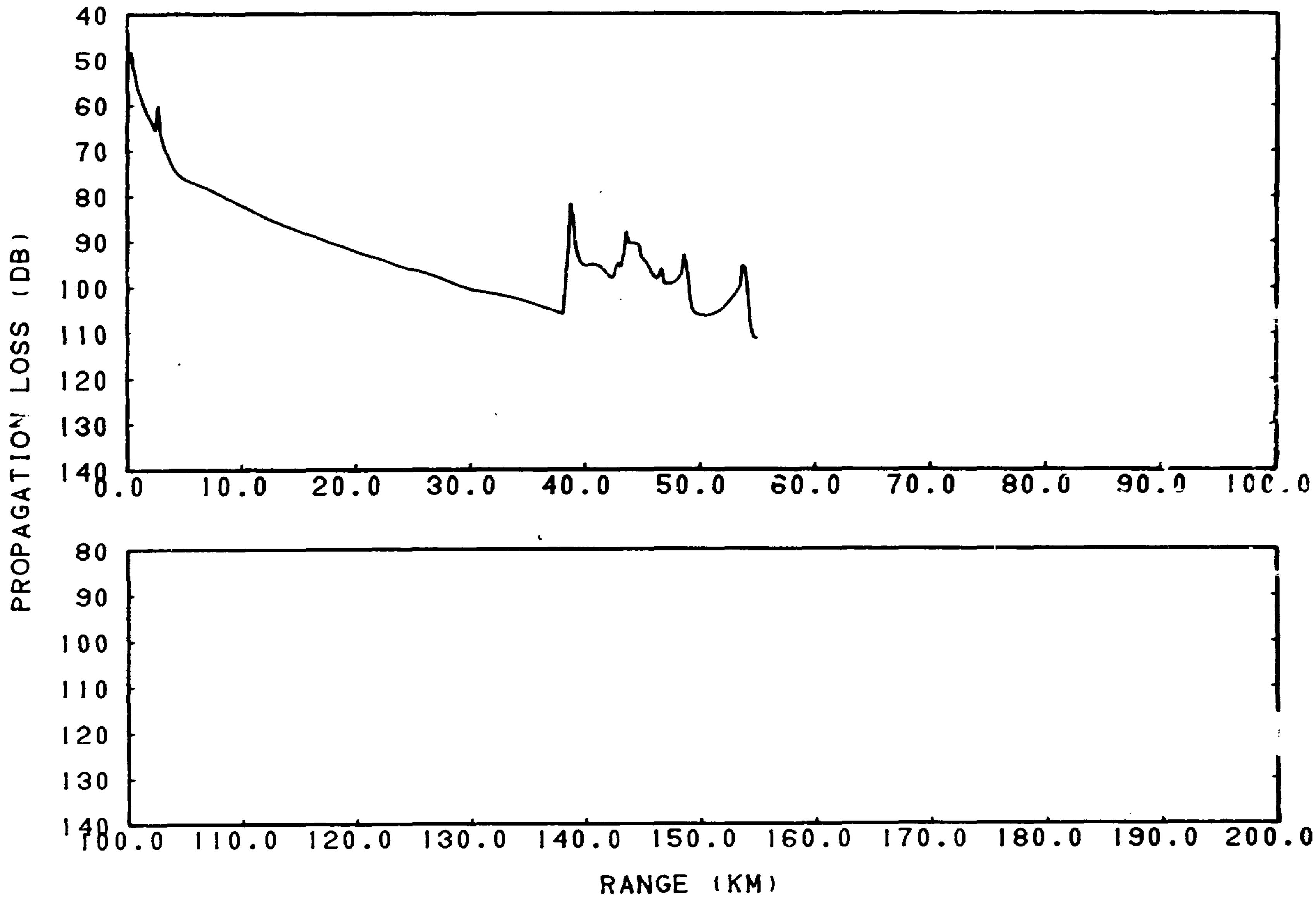
CONFIDENTIAL

(C) Figure IIF-21c. FACT Coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 1000 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



CONFIDENTIAL

(C) Figure IIF-21d. Smoothed FACT Coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 1000 Feet, Subtracted from Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 1000 Feet



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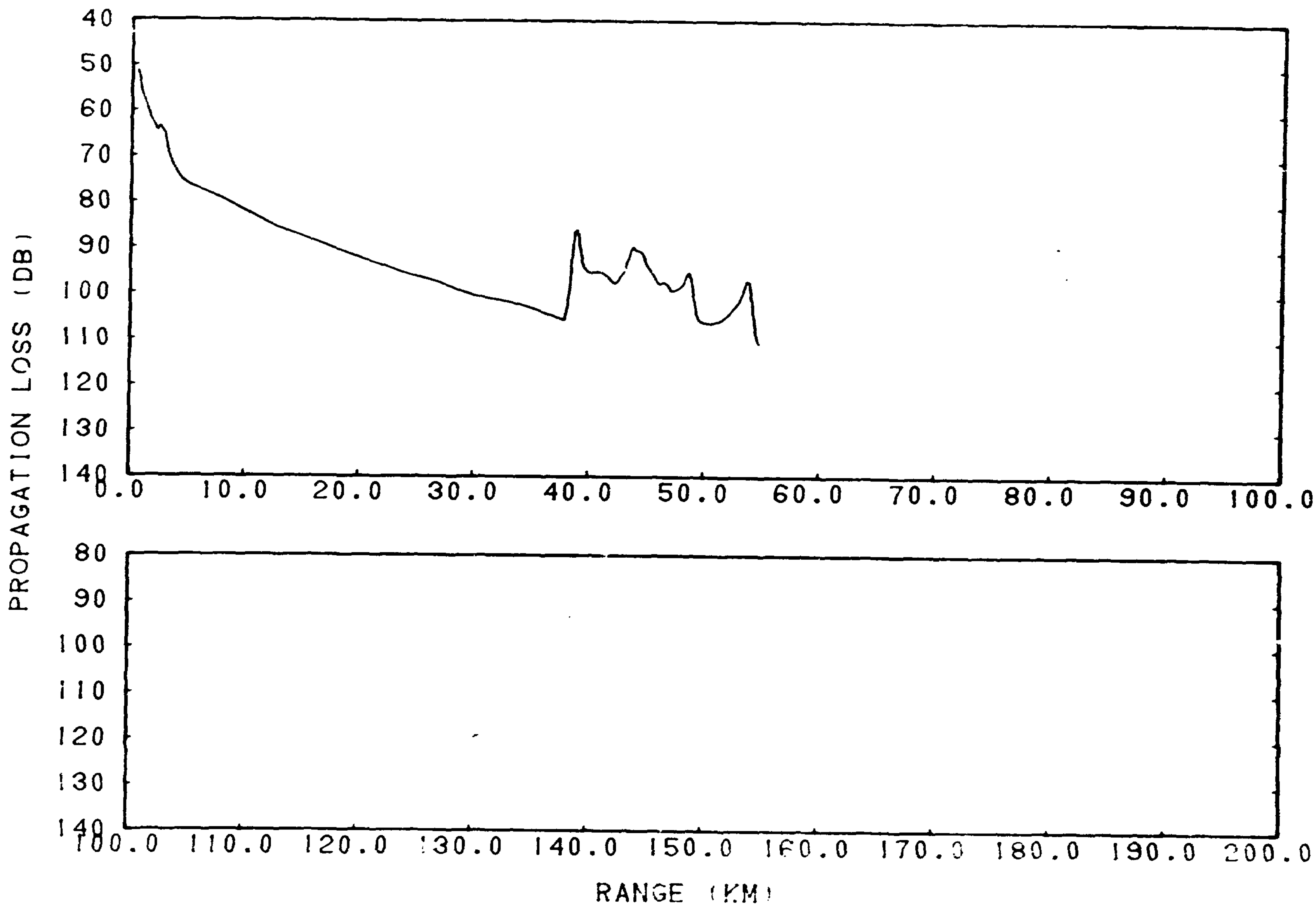
(C) Figure IIF-21e. FACT Semi-coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 1000 Feet



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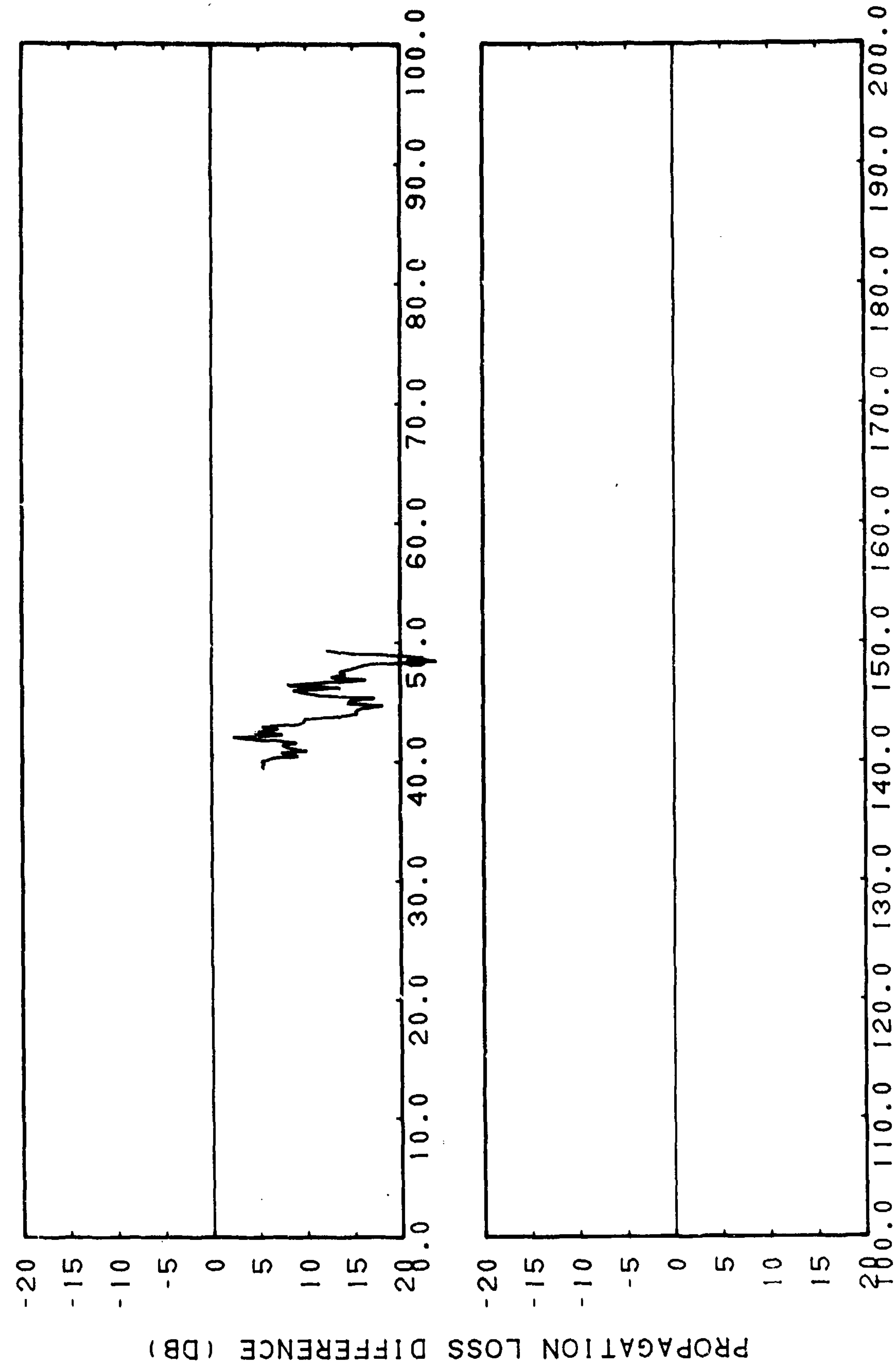
(C) Figure IIF-21f. FACT Semi-coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 1000 Feet, Sliding Averages of 3 Points (0.43 Kilometer)



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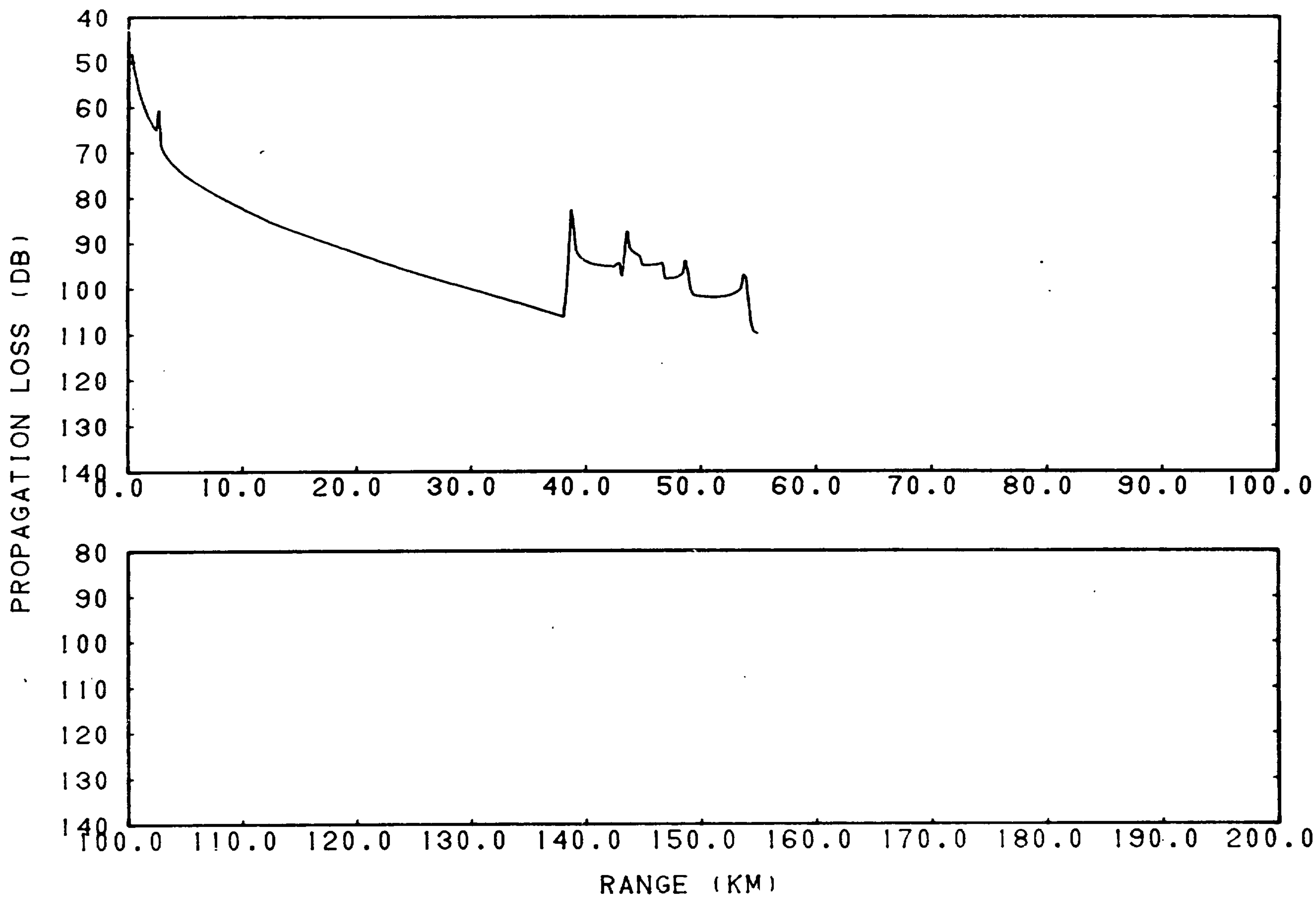
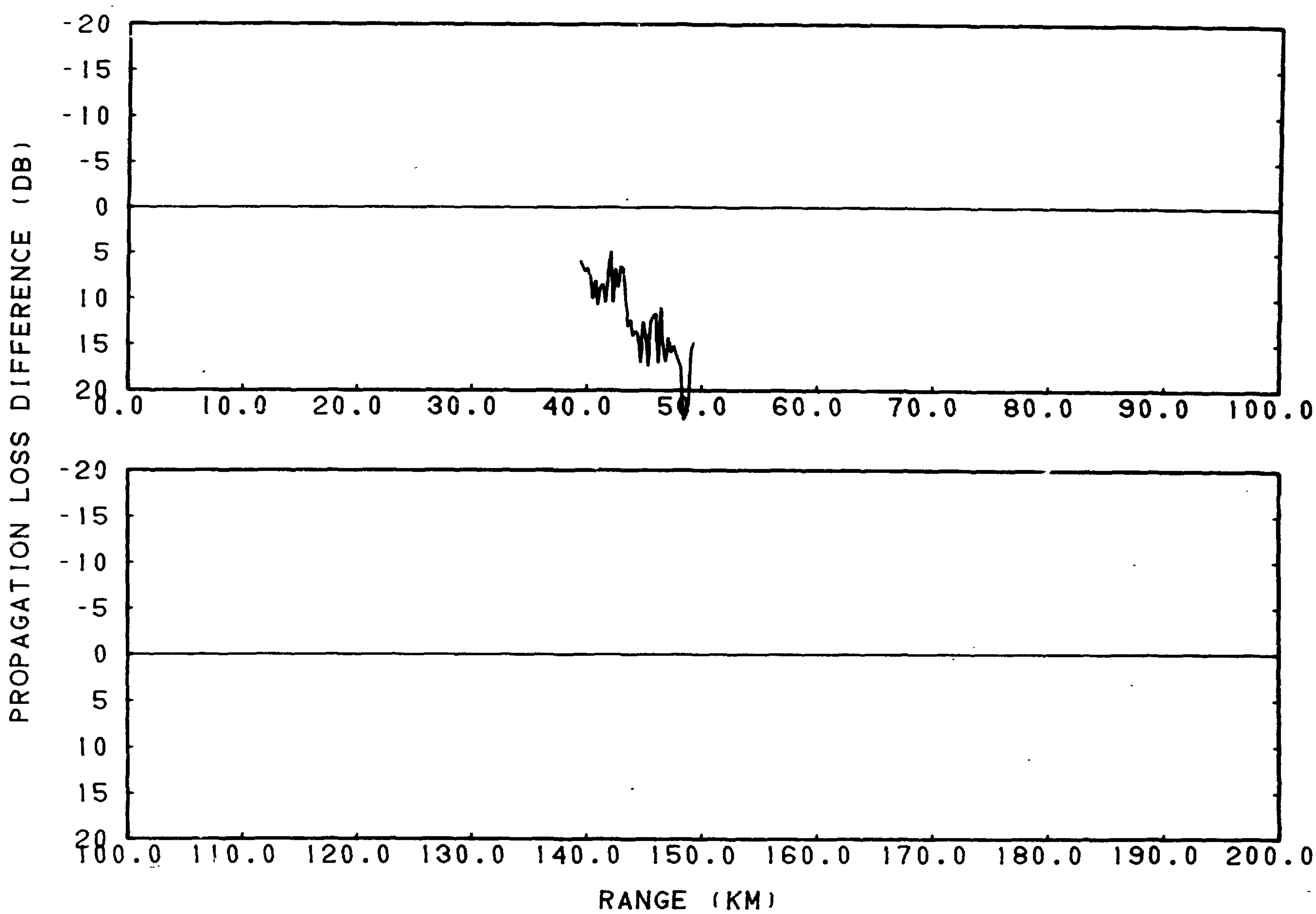
(C) Figure IIF-21g. Smoothed FACT Semi-coherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 1000 Feet, Subtracted from Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 1000 Feet



CONFIDENTIAL

(C) Figure IIF-21h. FACT Incoherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 1000 Feet



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(C) Figure IIF-21i. FACT Incoherent Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 1000 Feet, Subtracted from Station 5 Run 43, Source Depth = 20 Feet, Receiver Depth = 1000 Feet

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Appendix IIG. Accuracy Assessment of FACT PL9D Compared to FASOR Experimental Data IIG-1 (U)

FASOR (U)

Environment (U)

(C) The FASOR environments selected for the purpose of model evaluation were from stations designated as FIG, OAK, THORN, and REDWOOD. The sound speed profiles and their tabulations for these stations are given in Figures IIG1-IIG4, respectively. The station FIG sound speed profile consists of three negative gradients, representative of an arctic environment. The first gradient extends to 75 meters, the second is a strong thermocline to 150 meters, and the third gradient is essentially the pressure induced gradient extending to the bottom at 7648 meters. The station OAK sound speed profile consists of a surface duct to 30 meters overlying a channel with substantial negative depth excess which extends to the bottom at 120 meters. The station THORN sound speed profile consists of a negative gradient (i.e., a surface duct) to 55 meters over a strong positive gradient intersecting the bottom at 104 meters. The sound speed structure at station REDWOOD is a broad sound channel with axis at 1200 meters. The channel is bottom limited and intersects the bottom at 3282 meters. The negative depth excess is approximately 1600 meters.

(C) The bottom loss versus grazing angle curve for station FIG is plotted in Figure IIG-5 and listed in Table IIG-1. The loss at 0 degrees is 8 dB; at 18 degrees the loss has risen to 15 dB. From 19 degrees to 90 degrees the loss is between 15 and 16 dB. For FASOR stations OAK and THORN, the bottom loss is plotted in Figure IIG-6 and listed in Table IIG-2. The loss rises from a value of 3.5 dB at 0 degrees to a normal incidence value of 9 dB. At 15 degrees the bottom loss is 4.5 dB. The bottom loss versus grazing angle for station REDWOOD is given in Figure IIG-7 and Table IIG-3. The loss at zero degrees is 13 dB, at 10 degrees the loss is 24 dB. The bottom loss versus grazing angle curve has two maxima: 28.2 dB at 25 degrees and 26.5 dB at 80 degrees.

Test Cases (U)

(C) Six test cases from the FASOR experiments were selected for model evaluation as follows:

CASE	STATION	RUN	SOURCE DEPTH (m)	RECEIVER DEPTH (m)	FREQ. (kHz)	R_{min} (km)	R_{max} (km)
I	FIG	3	6.1	37	1.5	6.0	54.0
IIa	OAK	1	23.0	37	1.5	26.0	44.0
IIb	OAK	2	23.0	37	1.5	12.0	24.5
IIIa	THORN	1	23.0	37	1.5	19.5	33.5
IIIb	THORN	2	23.0	37	1.5	12.0	25.5
IV	REDWOOD	3	6.1	37	1.5	1.0	36.0

(C) Cases IIa and IIb pertain to a single environment and Cases IIIa and IIIb pertain to a different but single environment. Between Cases IIa and IIb there is a gap in data between 24.5 and 26 km. Cases IIIa and IIIb have a data overlap between 19.5 and 25.5 km. As mentioned above, Case II (i.e., station OAK) has a surface duct; the source is in the duct and the receiver below the duct. This case will therefore be dominated by contributions from bottom interacting paths. Case III (i.e., station THORN) also has a surface duct; in this case both source and receiver are in the duct. For station FIG (Case I) due to the large negative gradients, all energy will be transmitted from the shallow source to the shallow receiver (both in the uppermost gradient) by surface reflected paths with negligible bottom reflected energy. The station REDWOOD sound speed profile would indicate significant bottom interaction; however, a high loss (FNOC Type 8) bottom diminishes this contribution.

Accuracy Assessment Results (U)

(U) The accuracy assessment procedures were followed as outlined in section 1.1 and described in detail in section 5 of Volume I of this series. The following figures are given for each case: (1) The FASOR data for the six cases in Figures IIG-8 through IIG13, (2) the FASOR data smoothed by a running average with 2 kilometer window and overlap of 25% resulting in a point every 0.5 km. The smoothed data are plotted in Figures IIG-14 through IIG-19. (3a) The FACT PL9D model output and (3b) the FACT PL9D result subtracted from the smoothed FASOR data for the coherent, semicoherent and incoherent phase options. These are presented in sets of three pairs (corresponding to the three phase options) in Figures IIG-20 through IIG-55. As an examination of the figures reveals, the coherent and semicoherent results are identical for stations FIG, THORN, and REDWOOD (Cases I, IIIa, IIIb, and IV). The selected coherence option has been overridden internally in the FACT PL9D program. This sometimes occurs due to an error in logic whereby coherence is determined by testing the horizontal separation between the direct and surface reflected paths rather than on a ray-by-ray basis. This matter is discussed and an example given in section 5.0, "The Physics of the FACT Model," by C. L. Bartberger.

(C) The means and standard deviations of differences between the smoothed FASOR data and the FACT PL9D results are given in Table IIG-4. For Case I, the primary difference is a constant offset of 7 dB with the FASOR data showing greater loss than the FACT results. The FACT model does not take surface loss into account. In a case such as this, the addition of surface loss could result in the needed 7 dB increase in propagation loss to achieve agreement with the FASOR data. In Case IIa, the slope of the FACT propagation loss curve is similar to that of the FASOR data. This impression is enhanced if Case IIb is included in the analysis. The FASOR data exhibits 7-15 dB fluctuations whereas the FACT result shows no fluctuations in the same interval. Had the FASOR data been left unsmoothed, larger values of σ for Cases IIa and IIb would have resulted. In Cases IIIa and IIIb, the FACT model shows a physically unrealistic interference pattern of increasing amplitude with range. This pattern does, however, capture the extent of fluctuations observed in the unsmoothed data. In Case IV, station REDWOOD, the coherent FACT output shows much greater structure than exhibited by the FASOR data. Smoothing of this output, or alternately observing the incoherent results, and comparing to the FASOR data, gives smaller mean and standard deviation. Agreement, either qualitative or quantitative, is not achieved in this case in any event.

(C) The results of figure of merit (FOM) analysis are found in Tables IIG-5 to IIG-10 for the six cases. In Case I, due to the average higher loss of 7 dB shown by the FASOR data, the FACT model predicts optimistic detection coverage.

This is most dramatically revealed for an FOM of 85 dB for which the FASOR data would give a maximum detection range of 8.5 km while FACT predicts 23 km. For Cases IIa and IIb, the FOM results of Tables IIG-6 and IIG-7 show basic agreement between FASOR experimental and FACT model results. Typical is the Case IIb result for an FOM of 90 dB for which FASOR data gives a maximum detection range of 22 km compared to 23.5 km for FACT. Station THORN results (Cases IIIa and IIIb) are presented in Tables IIG-8 and IIG-9. The unrealistic nature of the FACT predictions for this case cast doubt on the detection ranges therefrom obtained. Nonetheless, the agreement be-between FASOR data and FACT results is quite good for FOM $\geq$ 85 dB, particularly if one looks at the detection percentage for Zonal Detection Coverage (ZDC). For FOMs of 75 or 80 dB, agreement is erratic and dependent on the phase option selected for FACT. For station REDWOOD, Case IV, the FASOR data gives much great greater detection ranges than does FACT, regardless of phase option selected.

(C) On the basis of the above, the following conclusions are drawn: (1) The FACT model yielded identical results for coherent and semicoherent phase options for stations FIG, THORN, and REDWOOD indicating that FACT over-rode the selected phase option internally in these cases. (2) The agreement between experimental data and model result was far better for the shallow water Cases IIa, IIb, IIIa, and IIIb than for the deep water Cases I and IV. (3) FACT demonstrated an unrealistic interference pattern for Case IIIa, IIIb. (4) FACT was excessively optimistic with respect to the data for the "high latitude" Case I and excessively pessimistic in the "mid-latitude" Case IV. In Case IV, the disagreement is likely due to the high bottom loss designated for this area.

(C) Table IIG-1. Bottom Loss in dB versus Grazing Angle in degrees for FASOR Station FIG (FNOC Type 5). Frequency = 1500 Hertz.

θ	BL	θ	BL	θ	BL	θ	BL	θ	BL	θ	BL
0	8.05	15	14.42	30	15.84	45	15.37	60	14.89	75	15.11
1	8.70	16	14.63	31	15.84	46	15.33	61	14.88	76	15.15
2	9.32	17	14.82	32	15.84	47	15.28	62	14.88	77	15.19
3	9.90	18	14.99	33	15.82	48	15.24	63	14.88	78	15.22
4	10.45	19	15.14	34	15.80	49	15.20	64	14.88	79	15.26
5	10.96	20	15.27	35	15.78	50	15.15	65	14.89	80	15.30
6	11.43	21	15.39	36	15.75	51	15.12	66	14.90	81	15.34
7	11.88	22	15.49	37	15.72	52	15.08	67	14.91	82	15.37
8	12.29	23	15.57	38	15.68	53	15.05	68	14.93	83	15.41
9	12.68	24	15.65	89	15.64	54	15.01	69	14.94	84	15.44
10	13.03	25	15.71	40	15.60	55	14.99	70	14.97	85	15.48
11	13.36	26	15.75	41	15.56	56	14.96	71	14.99	86	15.50
12	13.66	27	15.79	42	15.51	57	14.94	72	15.02	87	15.53
13	13.94	28	15.82	43	15.47	58	14.92	73	15.05	88	15.55
14	14.19	29	15.84	44	15.42	59	14.90	74	15.08	89	15.57

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(C) Table IIG-2. Bottom Loss in dB versus Grazing Angle in degrees for FASOR Stations OAK and THORN (FNOC Type 2, Frequency = 1500 Hertz).

θ	BL	θ	BL	θ	BL	θ	BL	θ	BL	θ	BL
0	3.49	15	4.77	30	6.48	45	7.91	60	8.72	75	8.95
1	3.54	16	4.88	31	6.59	46	7.98	61	8.75	76	8.96
2	3.60	17	5.00	32	6.70	47	8.06	62	8.78	77	8.96
3	3.67	18	5.11	33	6.81	48	8.13	63	8.81	78	8.96
4	3.74	19	5.22	34	6.91	49	8.19	64	8.83	79	8.96
5	3.81	20	5.34	35	7.01	50	8.26	65	8.85	80	8.96
6	3.89	21	5.45	36	7.11	51	8.32	66	8.87	81	8.96
7	3.98	22	5.57	37	7.21	52	8.37	67	8.89	82	8.96
8	4.07	23	5.69	38	7.31	53	8.43	68	8.90	83	8.96
9	4.16	24	5.80	39	7.40	54	8.48	69	8.91	84	8.96
10	4.25	25	5.90	40	7.49	55	8.53	70	8.92	85	8.96
11	4.35	26	6.03	41	7.58	56	8.57	71	8.93	86	8.97
12	4.45	27	6.15	42	7.67	57	8.61	72	8.94	87	8.97
13	4.56	28	6.26	43	7.75	58	8.65	73	8.95	88	8.98
14	4.67	29	6.37	44	7.83	59	8.69	74	8.95	89	8.99

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(C) Table IIG-3. Bottom Loss in dB versus Grazing Angle in degrees for FASOR Station REDWOOD (FNOC Type 8, Frequency = 1500 Hertz).

Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL
0	13.07	15	26.67	30	27.80	45	25.69	60	25.08	75	26.26
1	14.61	16	27.01	31	27.69	46	25.58	61	25.13	76	26.32
2	16.05	17	27.30	32	27.56	47	25.47	62	25.18	77	26.38
3	17.38	18	27.54	33	27.43	48	25.38	63	25.25	78	26.42
4	18.61	19	27.73	34	27.28	49	25.29	64	25.32	79	26.44
5	19.74	20	27.89	35	27.13	50	25.22	65	25.39	80	26.45
6	20.78	21	28.00	36	26.98	51	25.15	66	25.48	81	26.44
7	21.73	22	28.09	37	26.83	52	25.10	67	25.56	82	26.40
8	22.60	23	28.14	38	26.68	53	25.06	68	25.65	83	26.34
9	23.39	24	28.16	39	26.52	54	25.03	69	25.74	84	26.26
10	24.11	25	28.15	40	26.37	55	25.01	70	25.84	85	26.14
11	24.75	26	28.12	41	26.22	56	25.00	71	25.93	86	25.99
12	25.32	27	28.07	42	26.08	57	25.01	72	26.02	87	25.81
13	25.83	28	28.00	43	25.94	58	25.02	73	26.10	88	25.59
14	26.28	29	27.91	44	25.81	59	25.05	74	26.18	89	25.32

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(C) Table IIG-4. Means (μ) and Standard Deviations (σ) of Differences Obtained by Subtracting FACT PL9D Outputs with Coherent, Semicoherent, and Incoherent Phase Options from Smoothed[1] FASOR Experimental Data (in dB).

			Coherent Phase		Semicoherent Phase		Incoherent Phase	
Case	Station	Run	μ	σ	μ	σ	μ	σ
I	FIG	3	6.8	2.7	6.8	2.7	7.1	2.3
IIa	OAK	1	4.0	1.8	3.5	1.7	3.3	1.9
IIb	OAK	2	2.0	1.5	2.1	0.8	2.1	0.7
IIIa	THORN	1	-1.3	3.9	-1.3	3.9	2.4	3.6
IIIb	THORN	2	-4.4	3.3	-4.4	3.3	-2.6	3.9
IV	REDWOOD	3	-8.1	10.8	-8.1	10.8	-4.7	5.9

1. Smoothed by running average with a 2-km window and 25% overlap thereby generating one point every 0.5 km.

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(C) Table IIG-5. Detection Range in km as a Function of Figure of Merit (FOM) in dB for FASOR[1] Data (6-54 km) and FACT PL9D Model Results[2]. (Station FIG, Run 3, Source Depth = 6 m, Receiver Depth = 37 m, Frequency = 1.5 kHz).

Data Set	FOM	R_c[3]	Range > R_c
FASOR	85	?	ZDC[4] 50%, 6-8.5 km
FACT Coherent	85	23	
FACT Semicoherent[5]	85	23	
FACT Incoherent	85	23	
FASOR	90	17	ZDC 75%, 25-29 km. One peak at 32 km.
FACT Coherent	90	37.5	ZDC 60%, 37.5-48 km
FACT Semicoherent[5]	90	37.5	ZDC 60%, 37.5-48 km
FACT Incoherent	90	50	
FASOR	95	18	ZDC 70%, 18-52 km.
FACT Coherent	95	>54	
FACT Semicoherent[5]	95	>54	
FACT Incoherent	95	>54	
FASOR	100	>54	One dropout at 33 km.
FACT Coherent	100	>54	
FACT Semicoherent[3]	100	>54	
FACT Incoherent	100	>54	

1. FASOR data were not smoothed.
2. FACT model results were not smoothed.
3. R_c = Range to which coverage is continuous.
4. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.
5. FACT Coherent and Semicoherent results are identical.

(C) Table IIG-6. Detection Range in km as a Function of Figure of Merit (FOM) in dB for FASOR Data[1] (26-44 km) and FACT PL9D Model Results[2]. (Station OAK, Run 1, Source Depth = 23 m, Receiver Depth = 37 m, Frequency = 1.5 kHz.)

Data Set	FOM	R_c[3]	Range > R_c
FASOR	95	<26	
FACT Coherent	95	29	
FACT Semicoherent	95	29	
FACT Incoherent[5]	95	29	
FASOR	100	<26	ZDC[4] 80%, 26-28 km
FACT Coherent	100	35	
FACT Semicoherent	100	34	
FACT Incoherent[5]	100	34	
FASOR	105	29	ZDC 70%, 29-32 km; 100% coverage 32-36 km; 50% coverage 36-44 km.
FACT Coherent	105	40.5	
FACT Semicoherent	105	41.5	
FACT Incoherent[5]	105	41.5	
FASOR	110	39	ZDC 60%, 39-44 km
FACT Coherent	110	>44	
FACT Semicoherent	110	>44	
FACT Incoherent[5]	110	>44	

1. FASOR data were not smoothed.
2. FACT model results were not smoothed.
3. R_c = Range to which coverage is continuous.
4. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.
5. FACT semicoherent and incoherent results are identical.

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(C) Table IIG-7. Detection Range in km as a Function of Figure of Merit (FOM) in dB for FASOR Data[1] (12-24.5 km) and FACT PL9D Model Results[2]. (Station OAK, Run 2, Source Depth = 23 m, Receiver Depth = 37 m, Frequency = 1.5 kHz.)

Data Set	FOM	R_c[3]	Range > R_c
FASOR	80	< 12	
FACT Coherent	80	14.5	
FACT Semicoherent	80	14.5	
FACT Incoherent[5]	80	14.5	
FASOR	85	19.5	ZDC[4] 10%, 19.5-21.5 km
FACT Coherent	85	19.5	
FACT Semicoherent	85	19	
FACT Incoherent[5]	85	19	
FASOR	90	18	ZDC 50%, 18-22 km
FACT Coherent	90	24.5	
FACT Semicoherent	90	23.5	
FACT Incoherent[5]	90	23.5	
FASOR	95	23	ZDC 50%, 23-24.5 km
FACT Coherent	95	>24.5	
FACT Semicoherent	95	>24.5	
FACT Incoherent[5]	95	>24.5	

1. FASOR data were not smoothed.
2. FACT model results were not smoothed.
3. R_c = Range to which coverage is identical.
4. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.
5. FACT semicoherent and incoherent results are identical.

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(C) Table IIG-8. Detection Range in km as a Function of Figure of Merit (FOM) in dB for FASOR Data[1] (19.5-33.5 km) and FACT PL9D Model Results[2]. (Station THORN, Run 1, Source Depth = 23 m, Receiver Depth = 37 m, Frequency = 1.5 kHz.)

Data Set	FOM	R_c[3]	Range > R_c or Comments
FASOR	80	<19.5	ZDC[4] 10%, 19.5-27 km
FACT Coherent[5]	80	15.5[7]	Peaks at 20 and 22.5 km
FACT Semicoherent[5,6]	80	15.5[7]	Peaks at 20 and 22.5 km
FACT Incoherent[5]	80		
FASOR	85	<19.5	ZDC 65%, 19.5-23.5 km, ZDC 20%, 23.5-33.5 km.
FACT Coherent[5]	85	21	ZDC 65%, 21-33.5 km
FACT Semicoherent[5,6]	85	21	ZDC 65%, 21-33.5 km
FACT Incoherent[5]	85	16[7]	ZDC 55%, 16-27.5 km
FASOR	90	28	ZDC 50%, 28-33.5 km
FACT Coherent[5]	90	26	ZDC 50%, 26-33.5 km
FACT Semicoherent[5,6]	90	26	ZDC 50%, 26-33.5 km
FACT Incoherent[5,7]	90	22	ZDC 25%, 22-33.5 km
FASOR	95	>33.5	With the exception of one dropout at 29 km
FACT Coherent[5]	95	32.5	
FACT Semicoherent[5,6]	95	32.5	
FACT Incoherent[5]	95	>33.5	With the exception of two dropouts at 26 and 30 km

1. FASOR data were not smoothed.
2. FACT model results were not smoothed.
3. R_c = Range to which coverage is continuous.
4. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.
5. FACT coherent, semicoherent and incoherent results are unrealistically oscillatory.
6. FACT coherent and semicoherent results are identical.
7. Range given is outside range interval for FASOR data (i.e., 19.5-33.5 km).

(C) Table IIG-9. Detection Range in km as a Function of Figure of Merit (FOM) in dB for FASOR Data[1] (12-25.5 km) and FACT PL9D Model Results[2]. (Station THORN, Run 2, Source Depth = 23 m, Receiver Depth = 37 m, Frequency = 1.5 kHz.)

Data Set	FOM	R_c[3]	Range > R_c
FASOR	75	< 12	ZDC[4] 60%, 12-21 km
FACT Coherent[5]	75	11[7]	One peak at 13 km
FACT Semicoherent[5,6]	75	11[7]	One peak at 13 km
FACT Incoherent[5]	75	11.5[7]	ZDC 55%, 11.5-17 km
FASOR	80	14.5	ZDC 80%, 14.5-24 km
FACT Coherent[5]	80	15	ZDC 30%, 15-24 km
FACT Semicoherent[5,6]	80	15	ZDC 30%, 15-24 km
FACT Incoherent[5]	80	18	ZDC 40%, 18-27.5[7] km
FASOR	35	>22	ZDC 60%, 22-25.5 km
FACT Coherent[5]	85	21	ZDC 50%, 21-34.5[7] km
FACT Semicoherent[5,6]	85	21	ZDC 50%, 21-34.5[7] km
FACT Incoherent[5]	85	22	ZDC 70%, 22-48[7] km
FASOR	90	24.5	ZDC 50%, 24.5-25.5 km
FACT Coherent[5]	90	25.5	ZDC 50%, 25.5[7]-52.5[7] km
FACT Semicoherent[5,6]	90	25.5	ZDC 50%, 25.5[7]-52.5[7] km
FACT Incoherent[5]	90	>25.5	

1. FASOR data were not smoothed.
2. FACT model results were not smoothed.
3. R_c = Range to which coverage is continuous
4. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.
5. FACT coherent, semicoherent, and incoherent results are unrealistically oscillatory.
6. FACT coherent and semicoherent results are identical.
7. Range is outside interval for which there is FASOR data (i.e., 12-25.5 km).

(C) Table IIG-10. Detection Range in km as a Function of Figure of Merit (FOM) in dB for FASOR Data[1] (1-36 km) and FACT PL9D Model Results[2]. (Station REDWOOD, Run 3, Source Depth = 6 m, Receiver Depth = 37 m, Frequency = 1.5 kHz.)

Data Set	FOM	R_c[3]	Range > R_c
FASOR	85	?	
FACT Coherent	85	4	
FACT Semicoherent[5]	85	4	
FACT Incoherent	85	4	
FASOR	90	2.5	
FACT Coherent	90	5	
FACT Semicoherent[5]	90	5	
FACT Incoherent	90	5.5	
FASOR	95	5	ZDC[4] 60%, 5-11 km
FACT Coherent	95	7	
FACT Semicoherent[5]	95	7	
FACT Incoherent	95	7	
FASOR	100	11.5	ZDC 50%, 11.5-24.5 km
FACT Coherent	100	9	ZDC 50%, 9-11 km
FACT Semicoherent[5]	100	9	ZDC 50%, 9-11 km
FACT Incoherent	100	9	
FASOR	105	21.5	One dropout from 15 to 16 km
FACT Coherent	105	11	ZDC 25%, 11-18 km
FACT Semicoherent[5]	105	11	ZDC 25%, 11-18 km
FACT Incoherent	105	12.5	
FASOR	110	28.5	
FACT Coherent	110	11.5	ZDC 50%, 11.5-25 km
FACT Semicoherent[5]	110	11.5	ZDC 50%, 11.5-25 km
FACT Incoherent	110	18.5	
FASOR	115	29	One peak between 32 and 33 km
FACT Coherent	115	19	ZDC 50%, 19-25.5 km; ZDC 20%, 25.5-36 km
FACT Semicoherent[5]	115	19	ZDC 50%, 19-25.5 km; ZDC 20%, 25.5-36 km
FACT Incoherent	115	28.5	

1. FASOR data were not smoothed for FOM analysis.
2. FACT model results were not smoothed.
3. R_c = Range to which coverage is continuous.
4. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.
5. FACT coherent and semicoherent results are identical.

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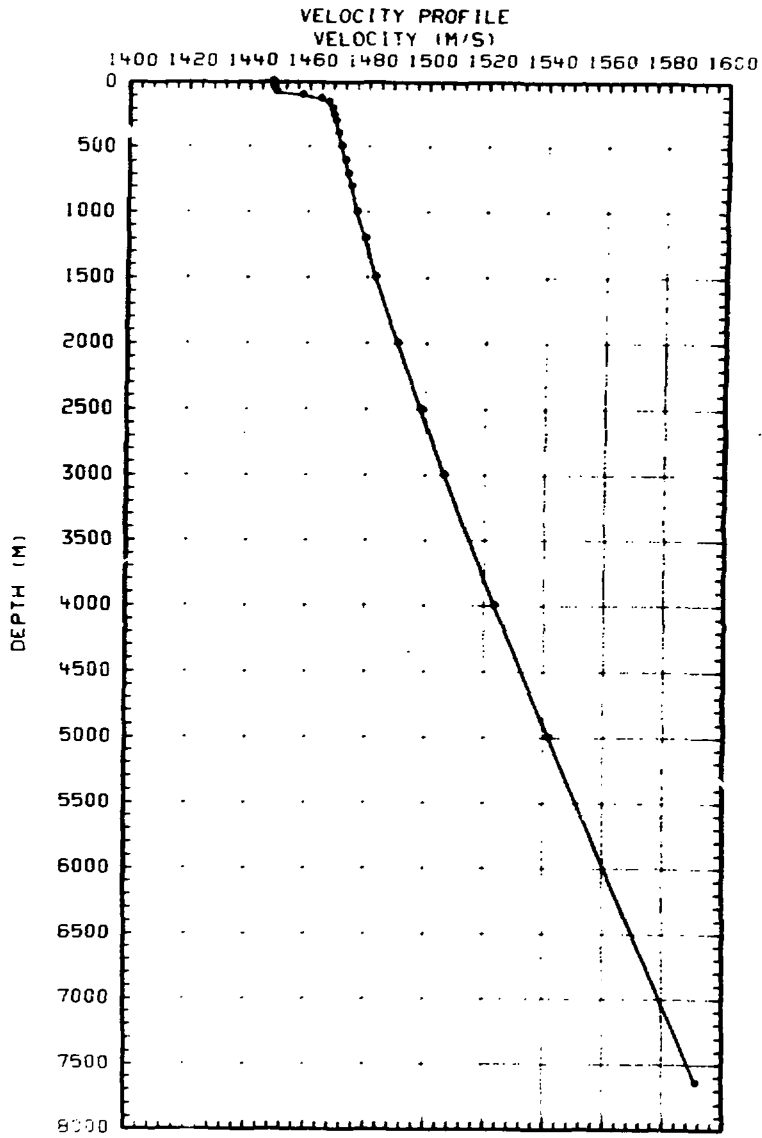
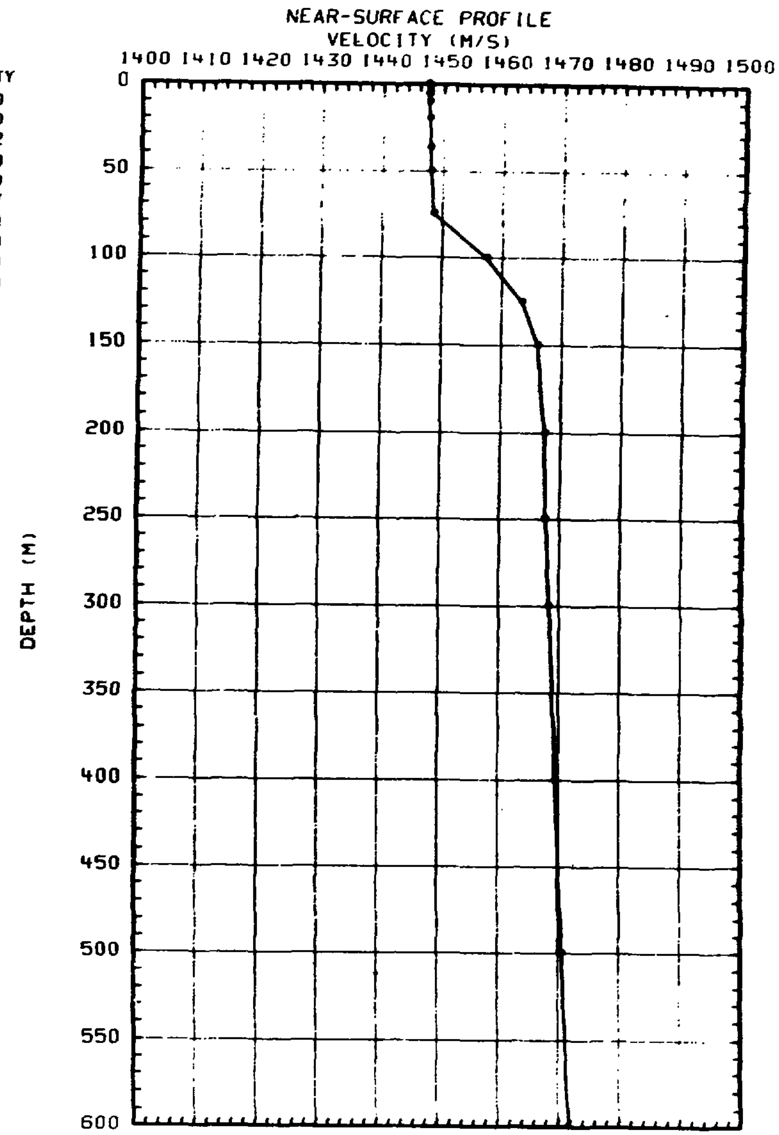


DEPTH	VELOCITY
0.0	1447.30
5.0	1447.40
6.1	1447.42
10.0	1447.50
20.0	1447.60
37.0	1447.77
50.0	1447.90
75.0	1448.60
100.0	1457.30
125.0	1463.40
150.0	1466.00
200.0	1467.30
250.0	1467.78
300.0	1468.40
400.0	1469.50
500.0	1470.60
600.0	1471.70
700.0	1472.80
[illegible]	1473.90
[illegible]	1476.20
[illegible]	1478.60
[illegible]	1482.60
2000.0	1490.20
2500.0	1498.10
3000.0	1506.30
4000.0	1523.50
5000.0	1541.80
7648.0	1591.30



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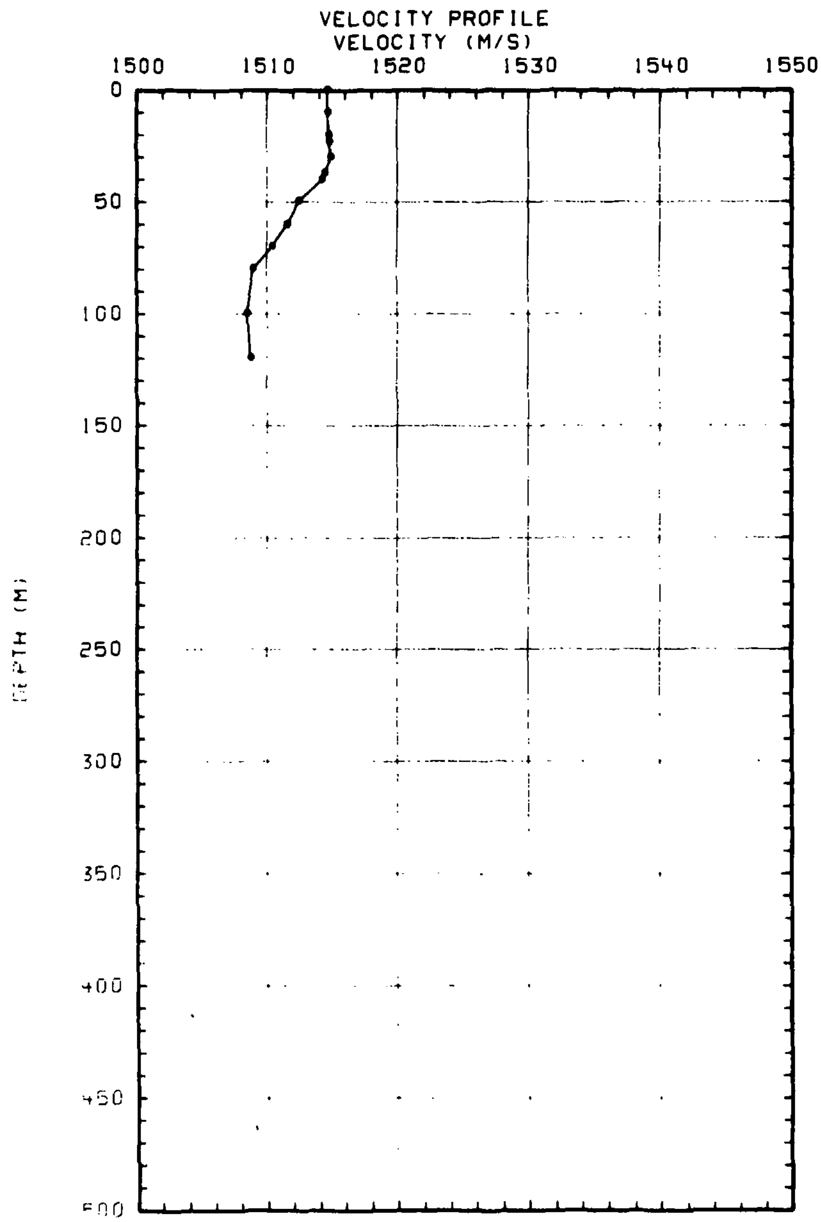
(U) Figure IIG-1. Sound Speed Versus Depth Profile for FASOR Station FIG



DEPTH	VELOCITY
0.0	1514.60
10.0	1514.70
20.0	1514.80
23.0	1514.83
30.0	1514.90
37.0	1514.41
40.0	1514.20
50.0	1512.40
60.0	1511.50
70.0	1510.40
80.0	1508.90
100.0	1508.40
120.0	1508.70

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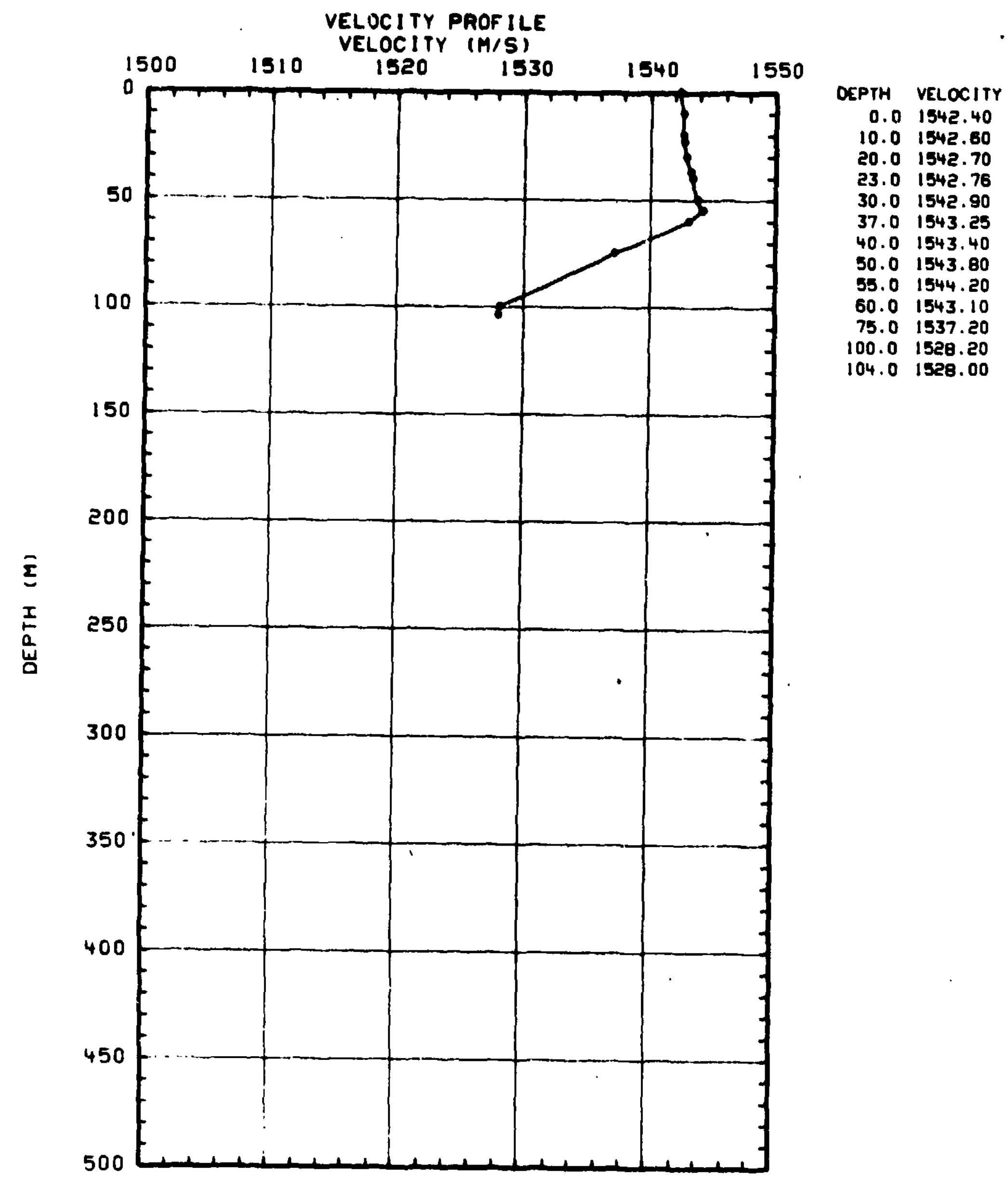
(U) Figure IIG-2. Sound Speed Versus Depth Profile for FASOR Station OAK



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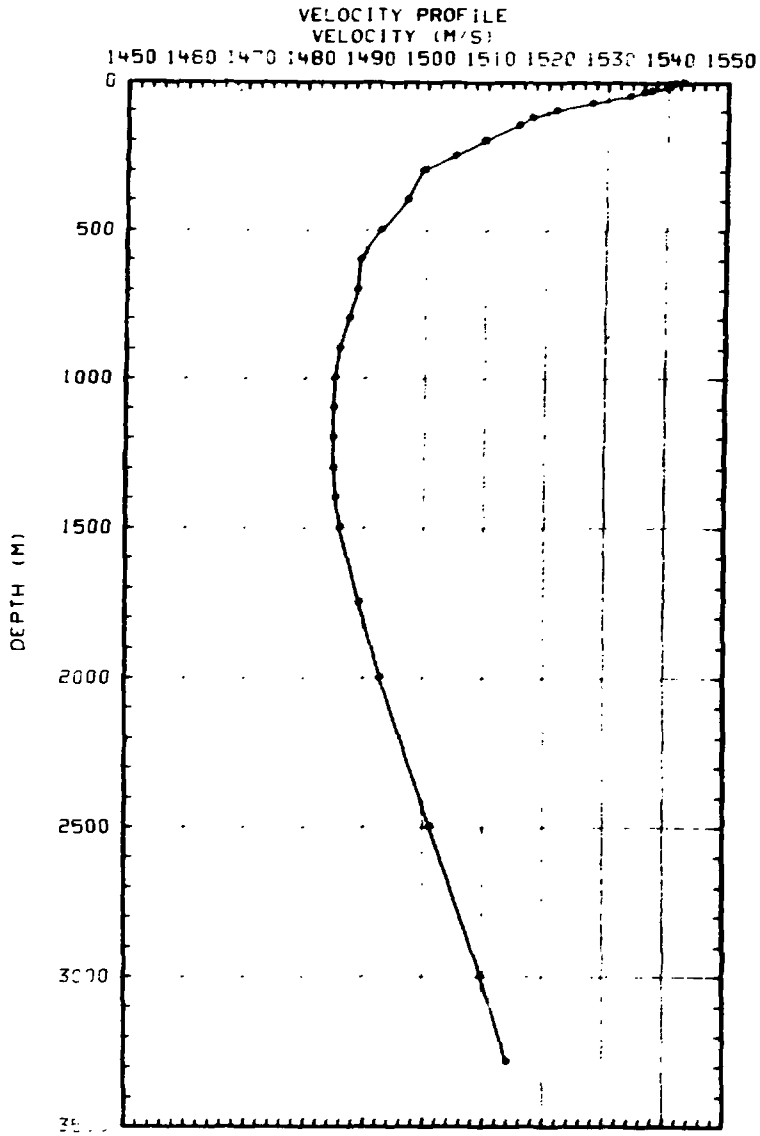
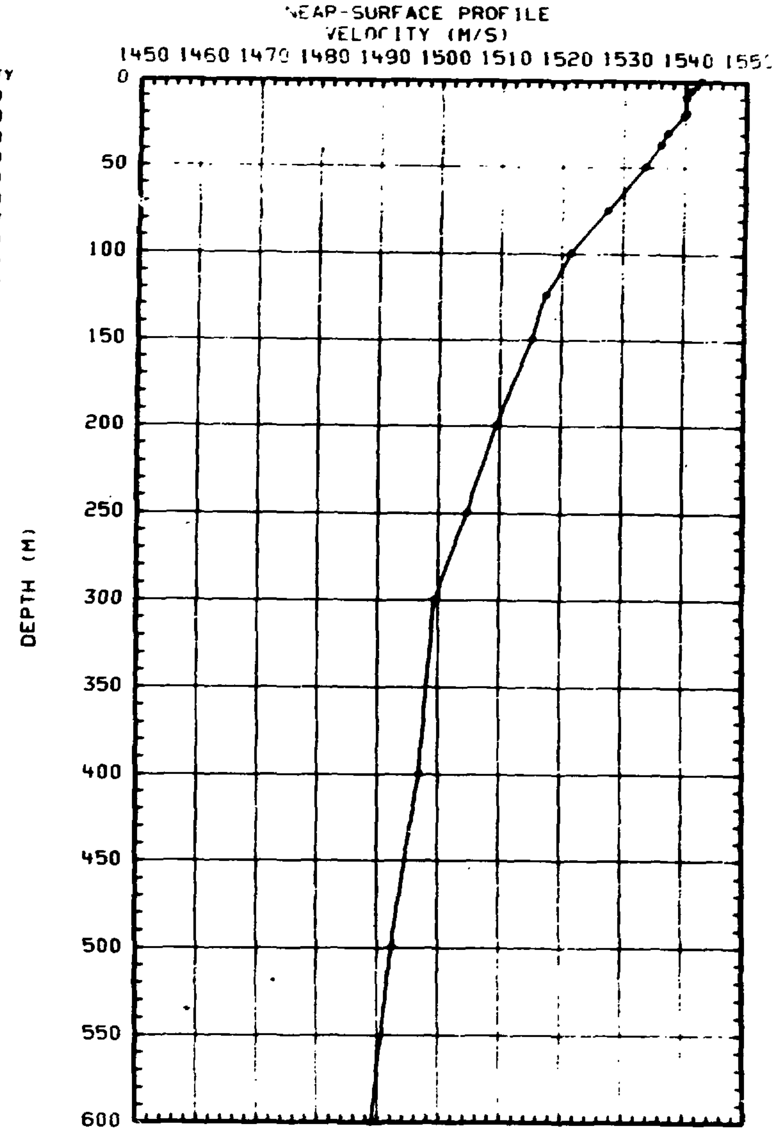
(U) Figure IIG-3. Sound Speed Versus Depth Profile for FASOR Station THORN



DEPTH	VELOCITY
0.0	1542.30
6.1	1540.90
10.0	1540.00
19.0	1540.10
20.0	1539.70
30.0	1537.10
37.0	1535.87
50.0	1533.60
75.0	1527.30
100.0	1521.40
125.0	1517.30
150.0	1515.10
200.0	1509.40
250.0	1504.60
300.0	1499.30
400.0	1496.80
500.0	1492.30
600.0	1489.00
700.0	1488.50
800.0	1487.30
900.0	1485.60
1000.0	1484.90
1100.0	1484.70
1200.0	1484.60
1300.0	1484.80
1400.0	1485.10
1500.0	1485.80
1750.0	1489.10
2000.0	1492.70
2500.0	1501.10
3000.0	1509.70
3282.0	1514.00



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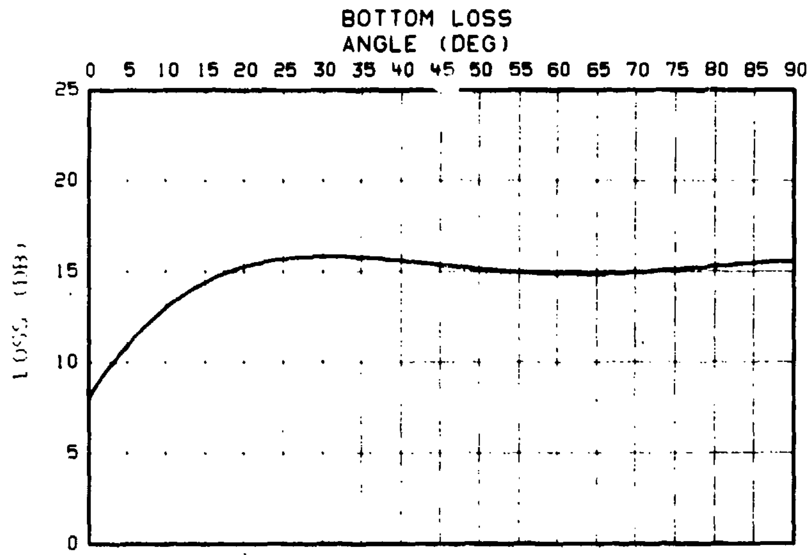
(U) Figure IIG-4. Sound Speed Versus Depth Profile for FASOR Station REDWOOD



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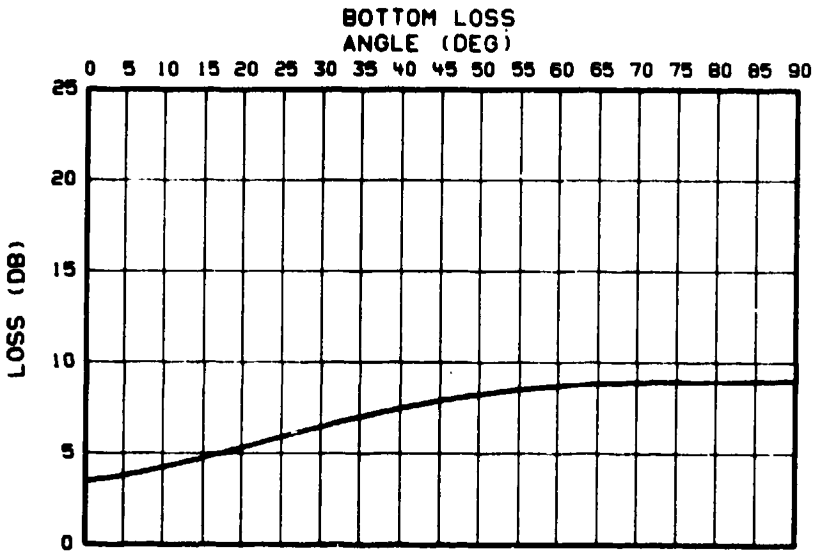
(C) Figure IIG-5. Bottom Loss Versus Grazing Angle for FASOR Station FIG (FNOC Type 5, Frequency = 1.5 Kilohertz)



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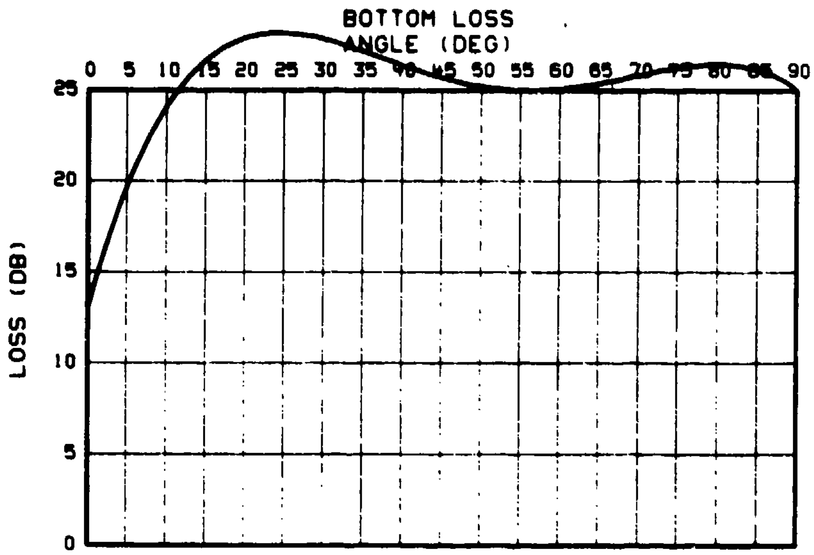
(C) Figure IIG-6. Bottom Loss Versus Grazing Angle for FASOR Stations OAK and THORN (FNOC Type 2, Frequency = 1.5 Kilohertz)



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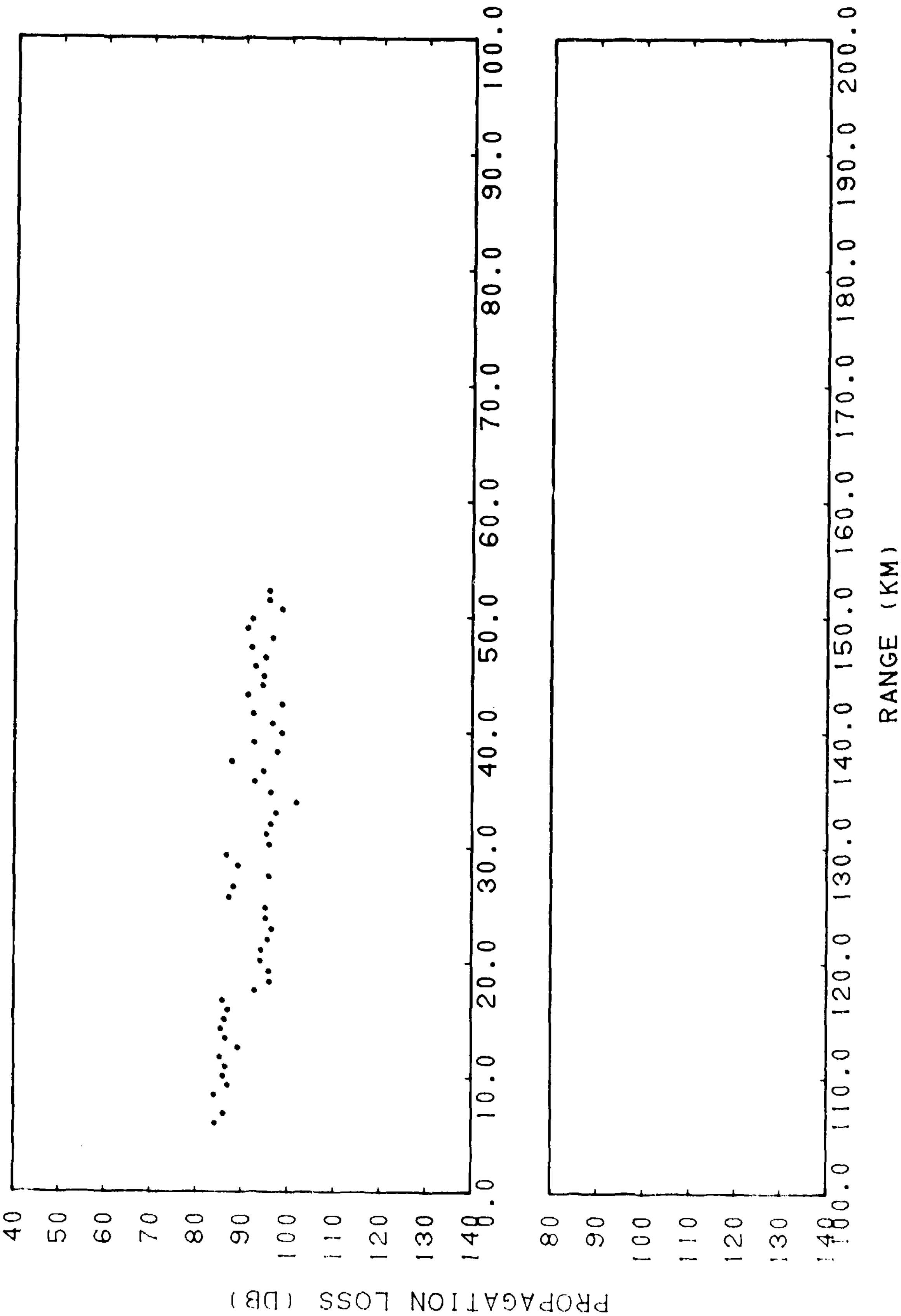
(C) Figure IIG-7. Bottom Loss Versus Grazing Angle for FASOR Station REDWOOD (FNOC Type 8, Frequency = 1.5 Kilohertz)



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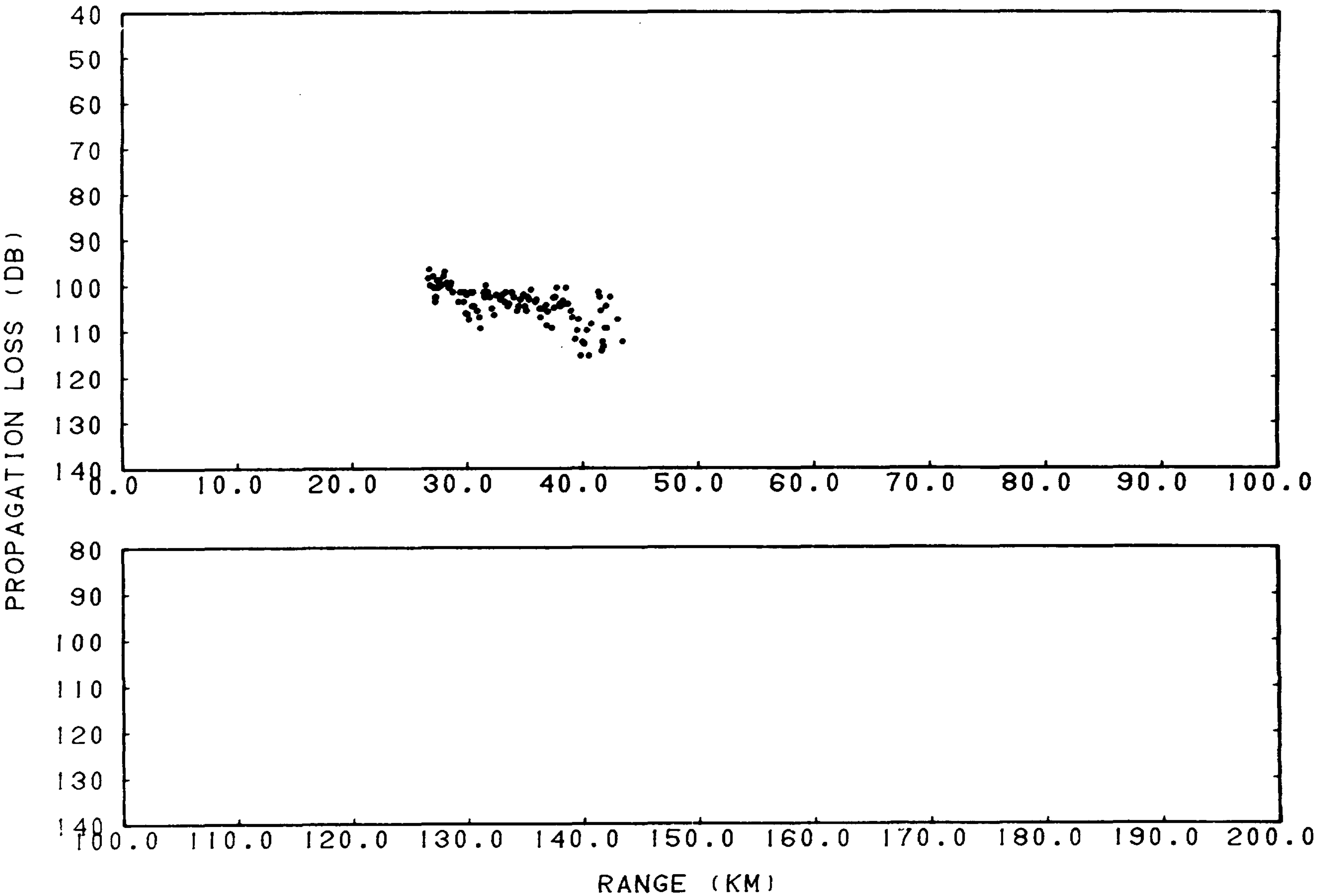
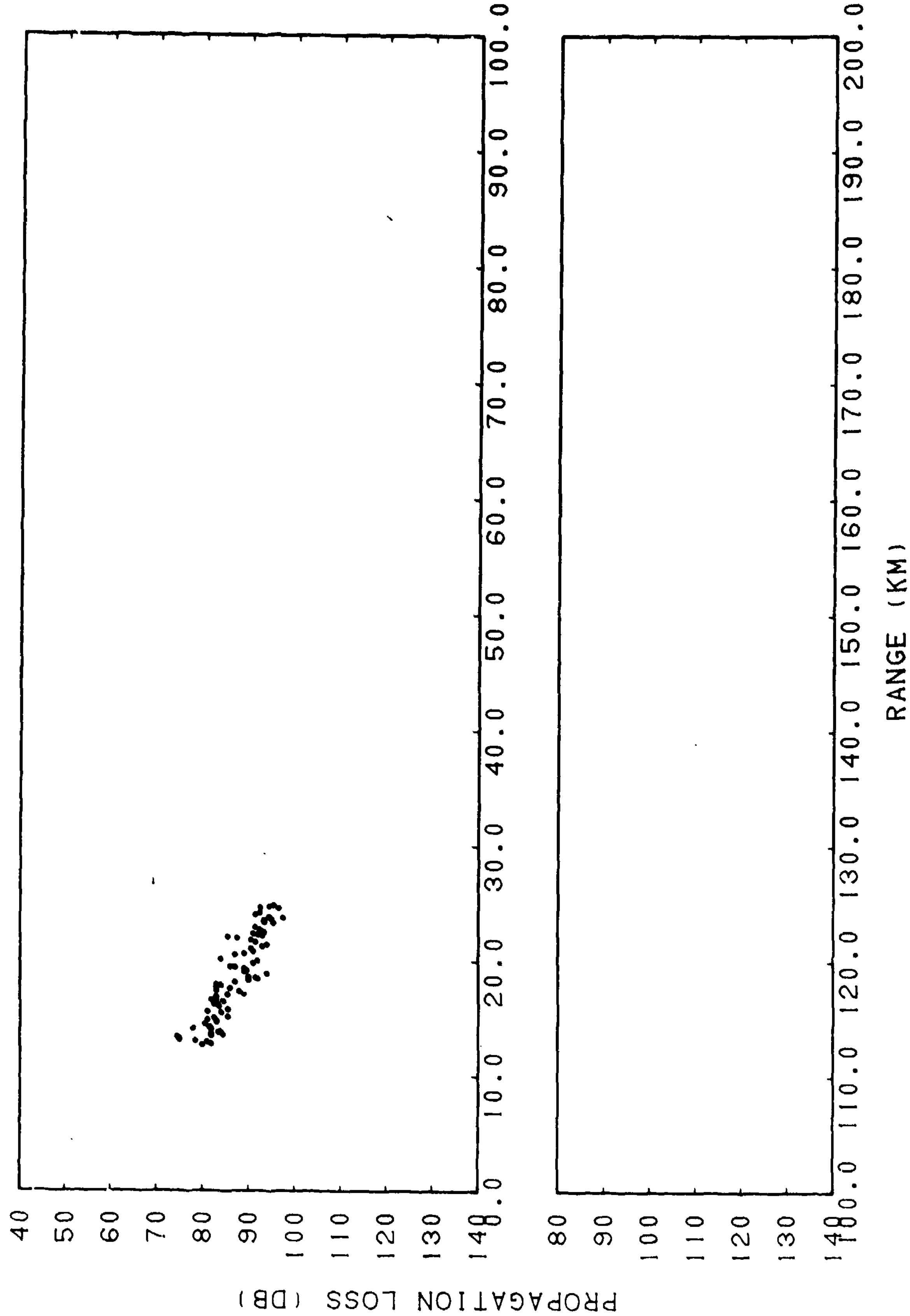
(C) Figure IIG-8. FASOR Station FIG, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



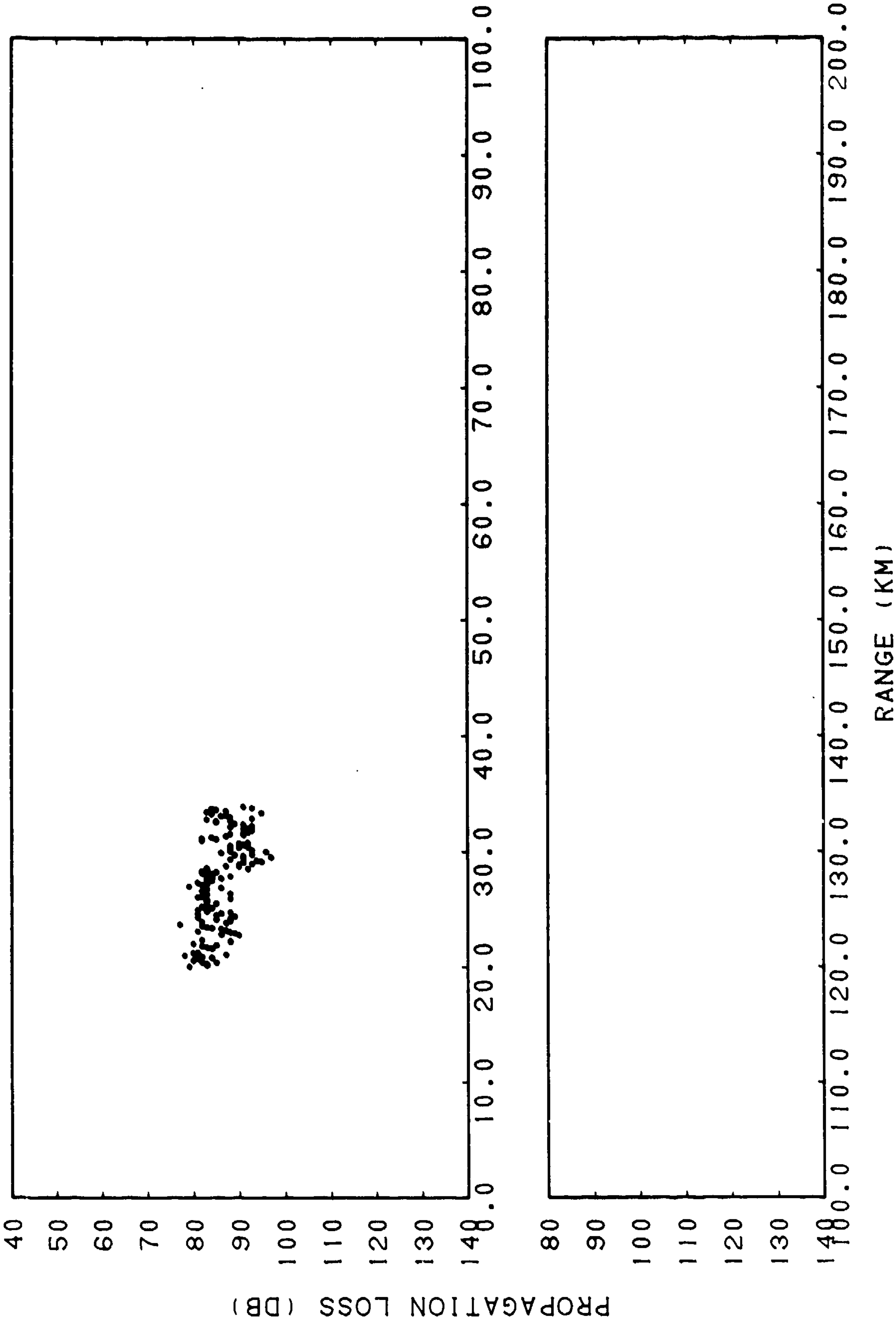
CONFIDENTIAL

(C) Figure IIG-9. FASOR Station OAK, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



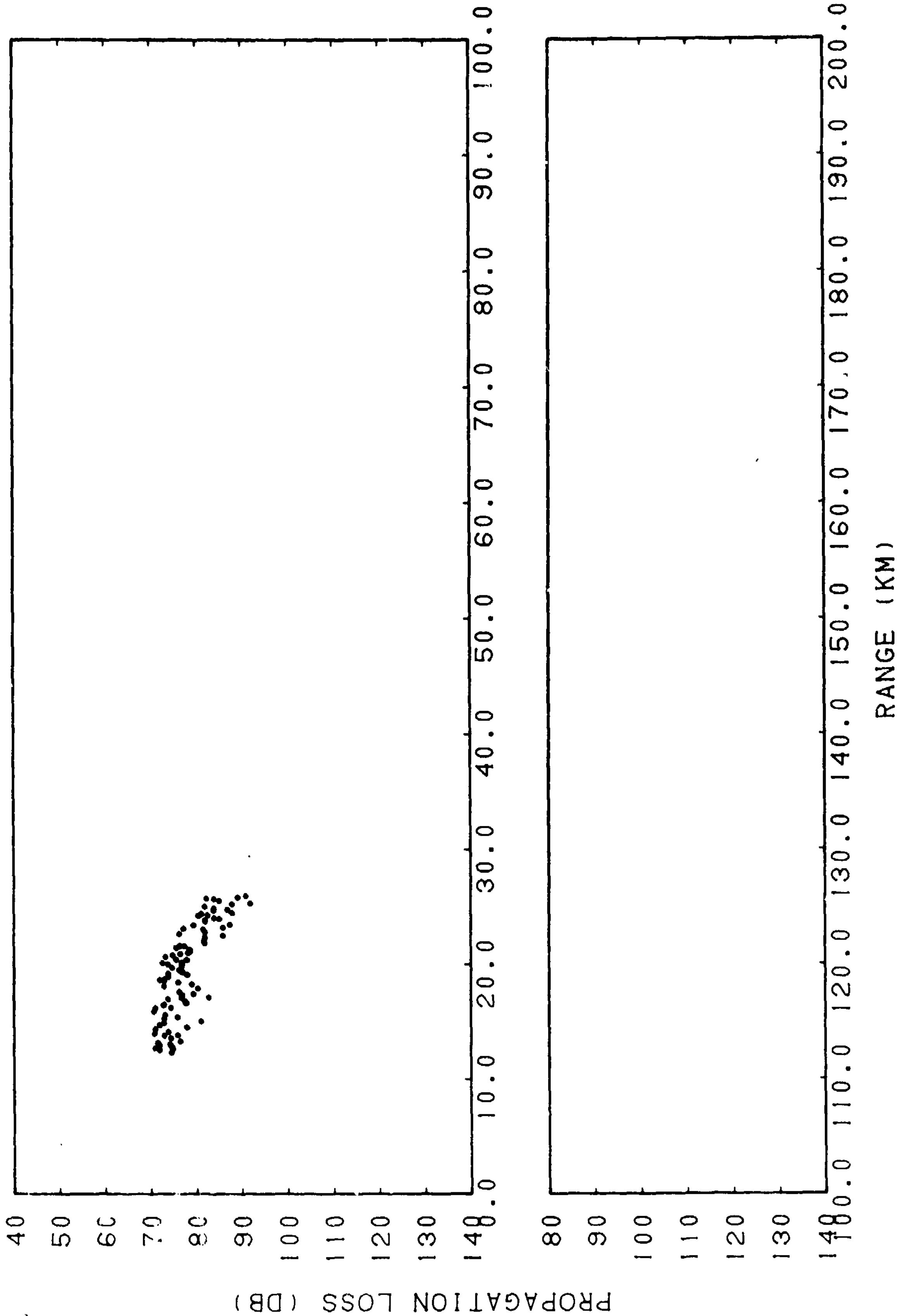
CONFIDENTIAL

(C) Figure IIG-10. FASOR Station OAK, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



CONFIDENTIAL

(C) Figure IIG-11. FASOR Station THORN, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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(C) Figure IIG-12. FASOR Station THORN, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz

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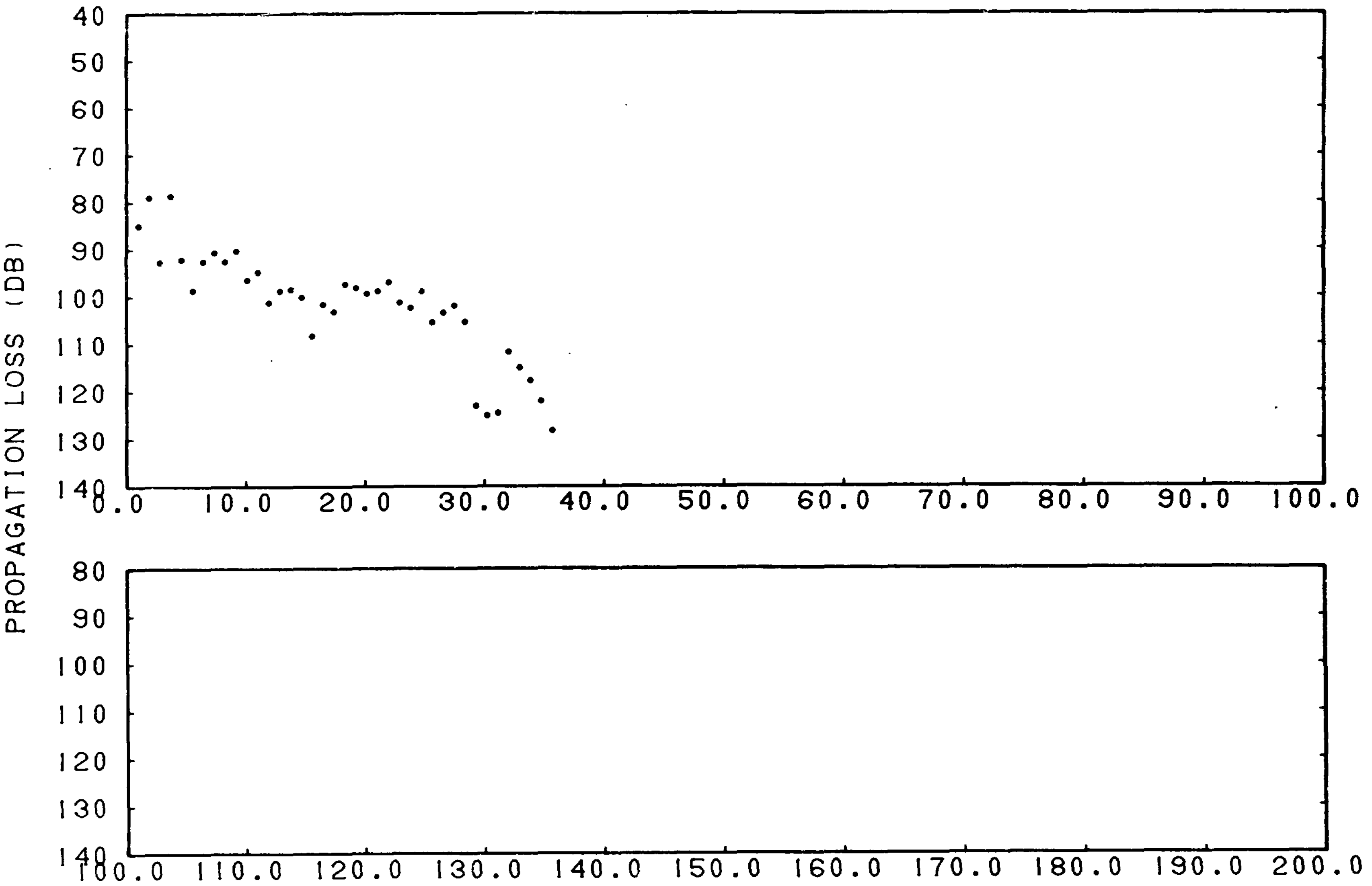
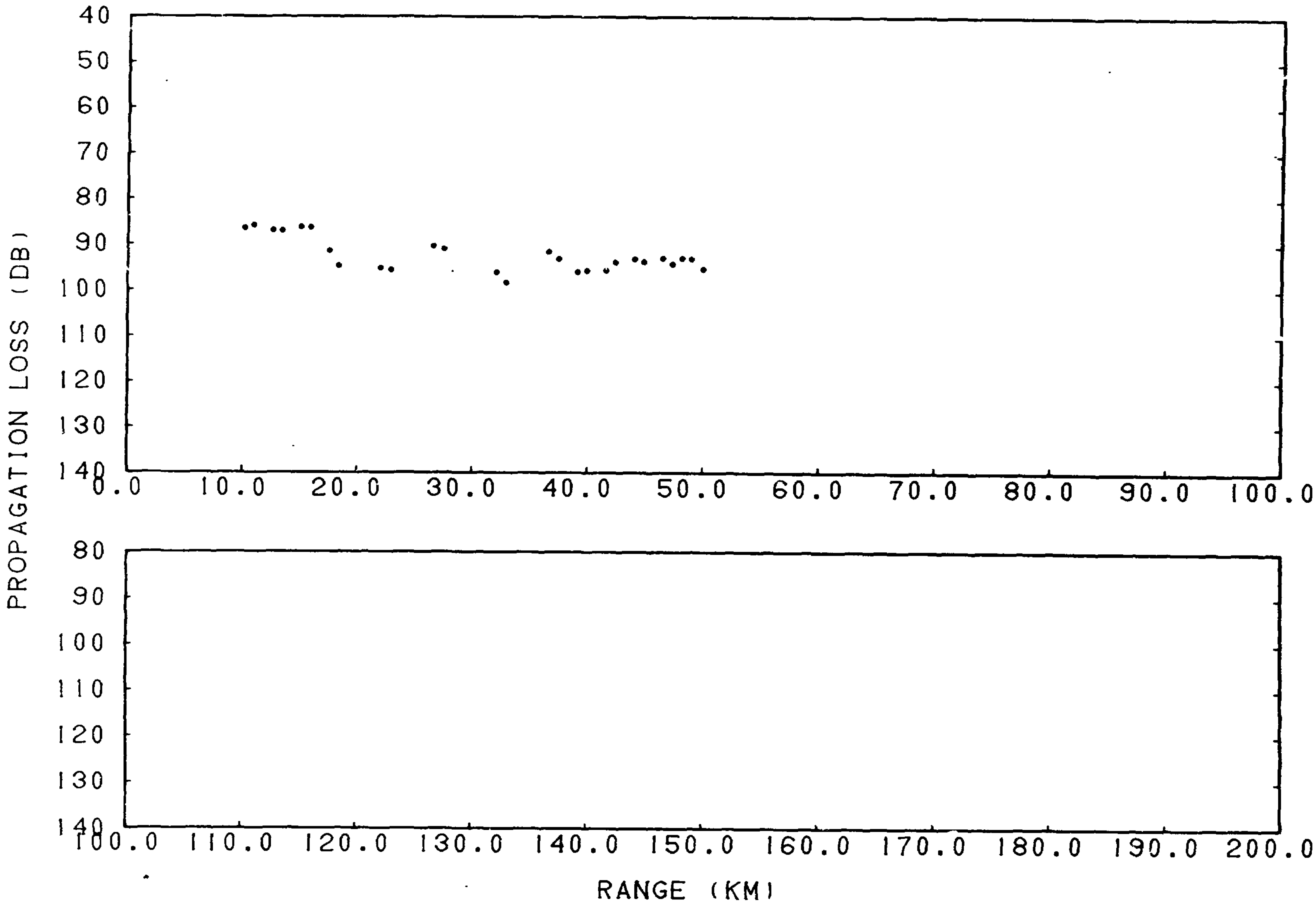


CONFIDENTIAL

(C) Figure IIG-13. FASOR Station REDWOOD, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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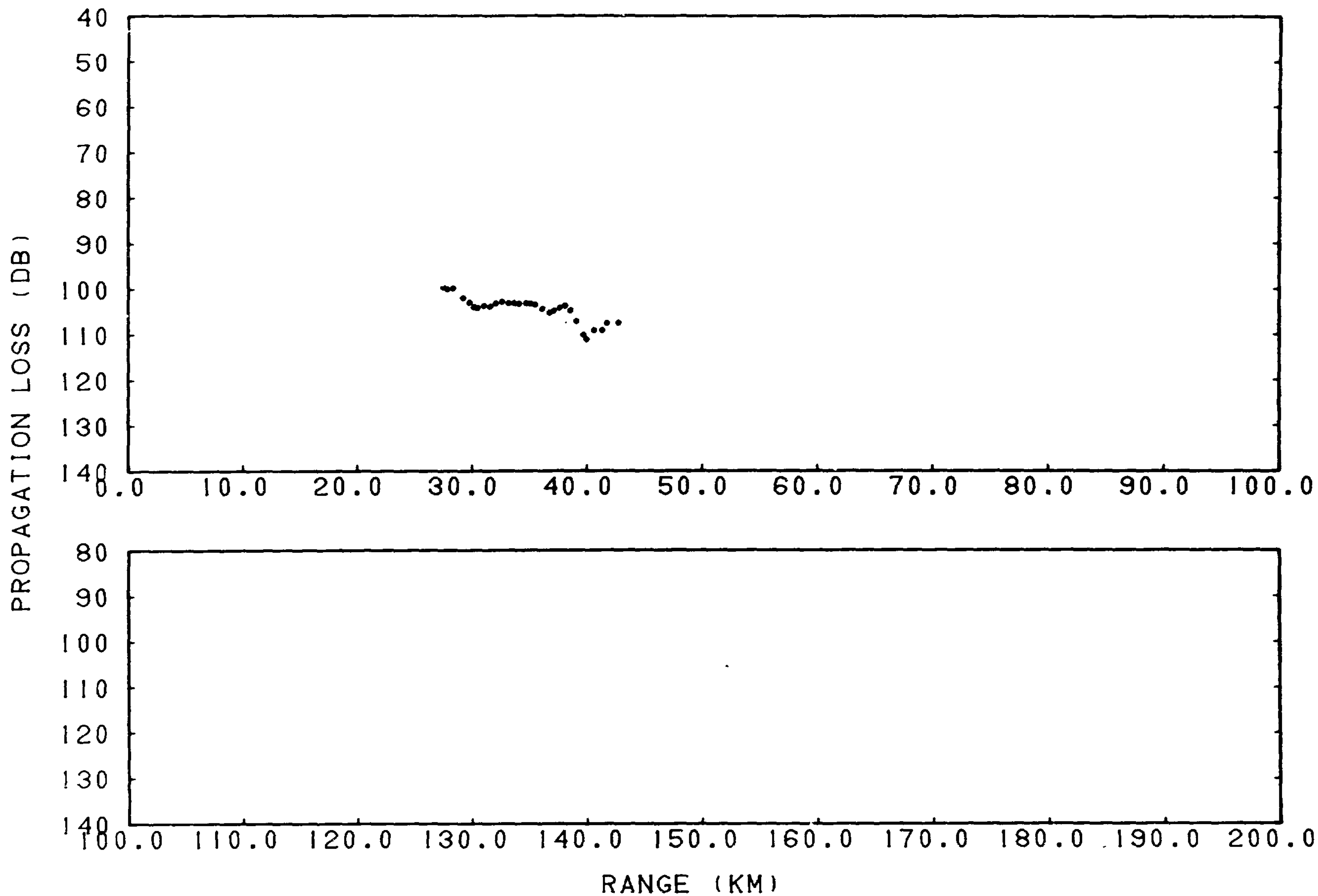
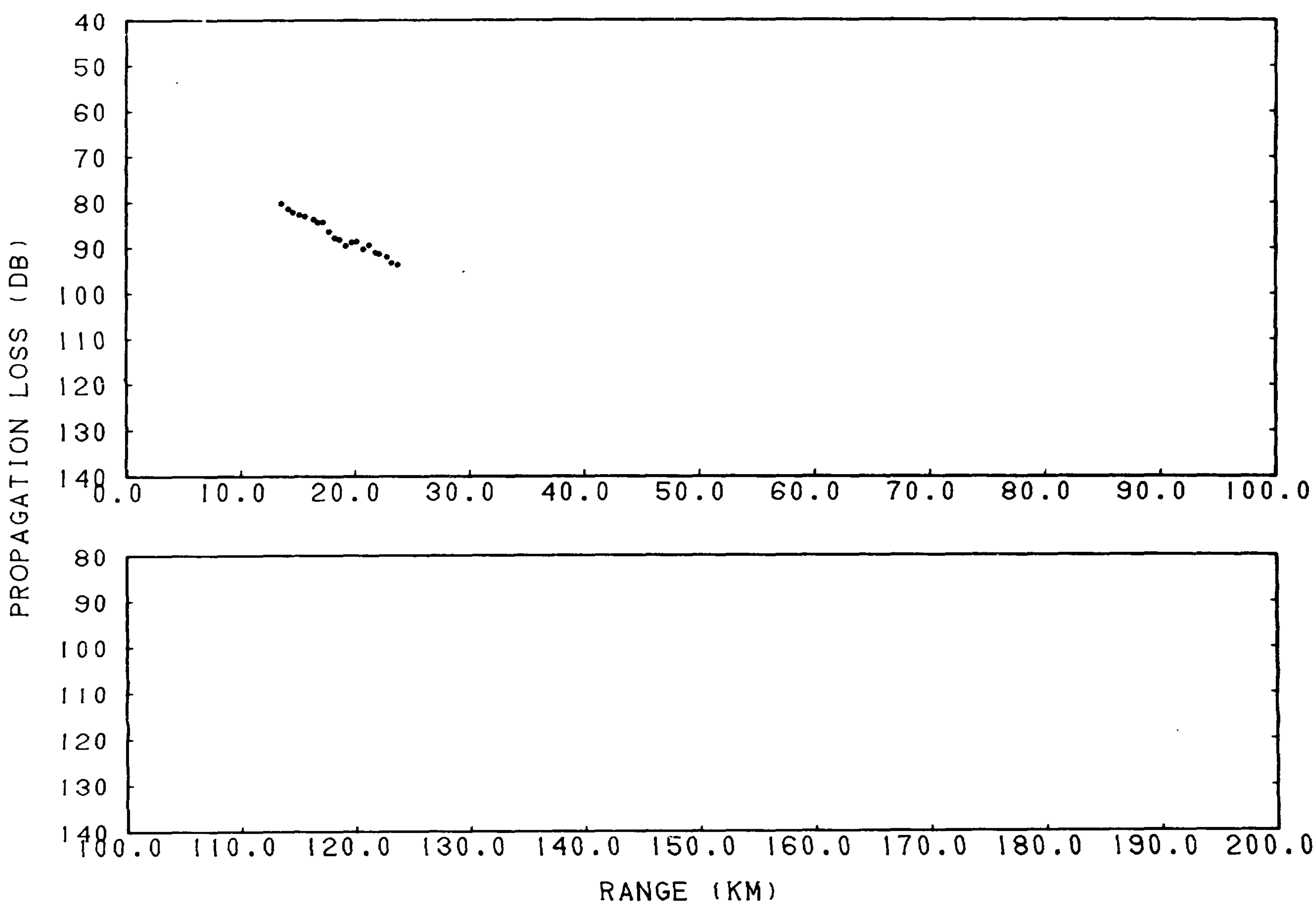
(C) Figure IIG-14. Smoothed FASOR Station FIG, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



CONFIDENTIAL

(C) Figure IIG-15. Smoothed FASOR Station OAK, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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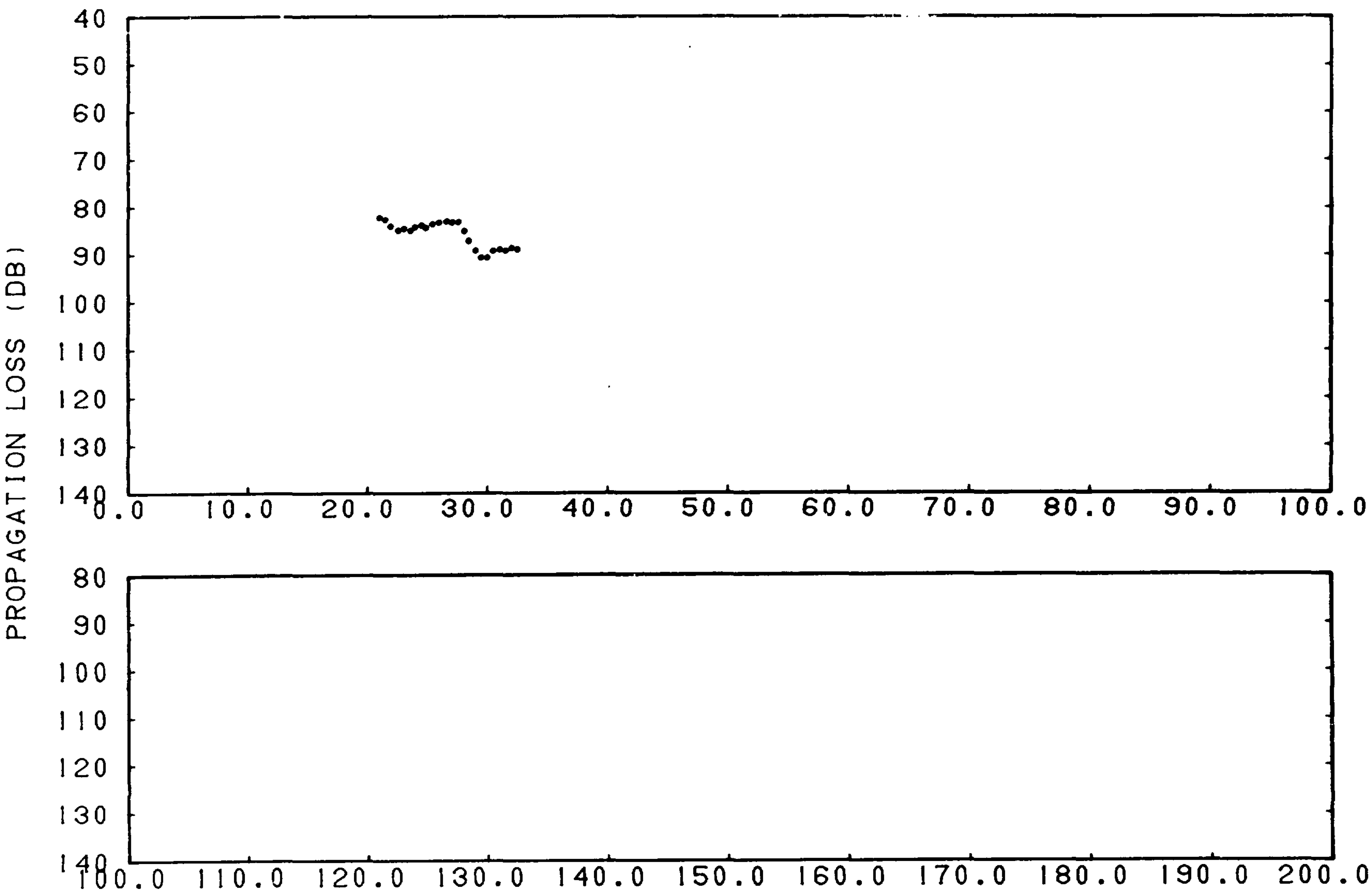
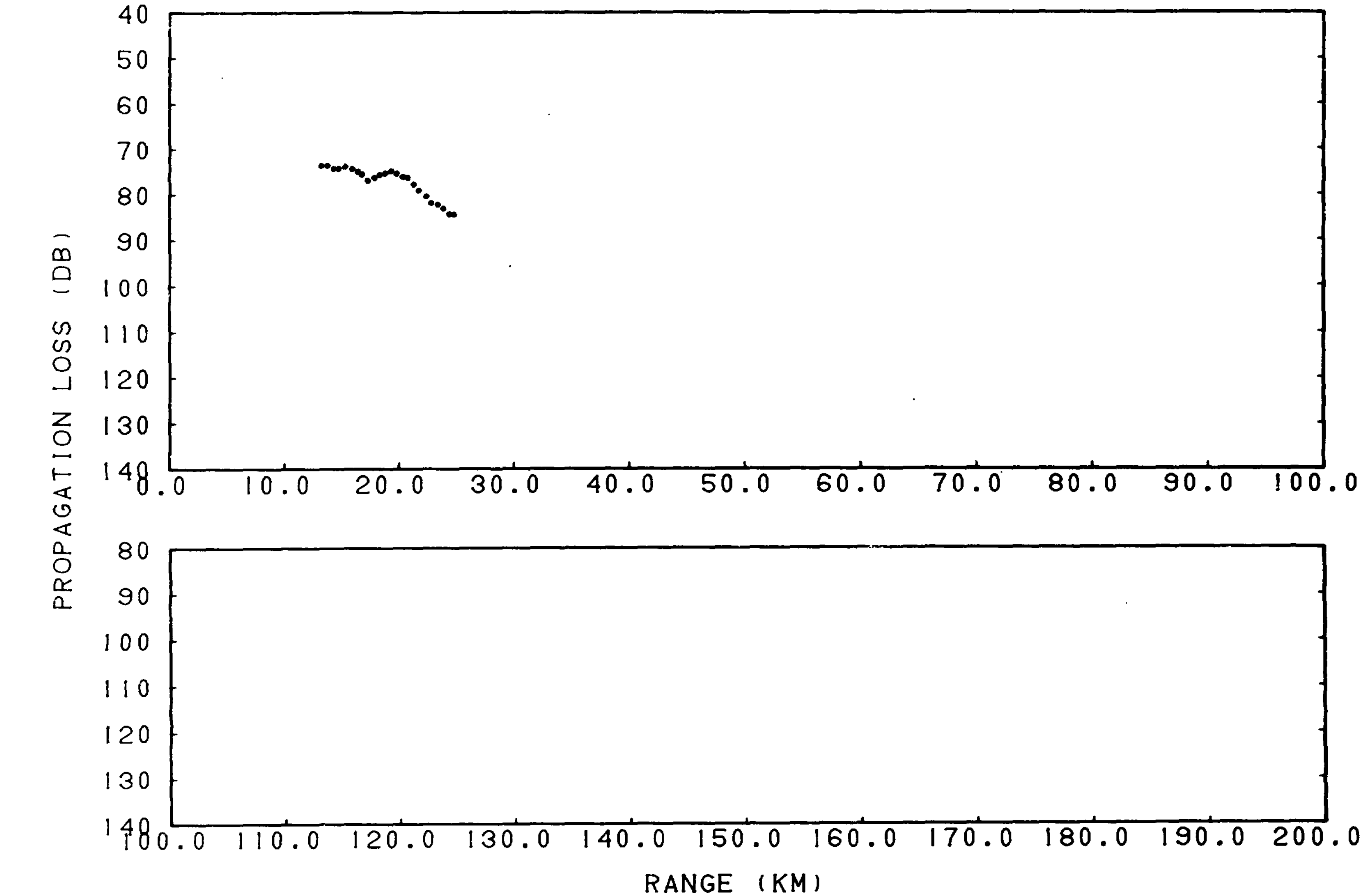
(C) Figure IIG-16. Smoothed FASOR Station OAK, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



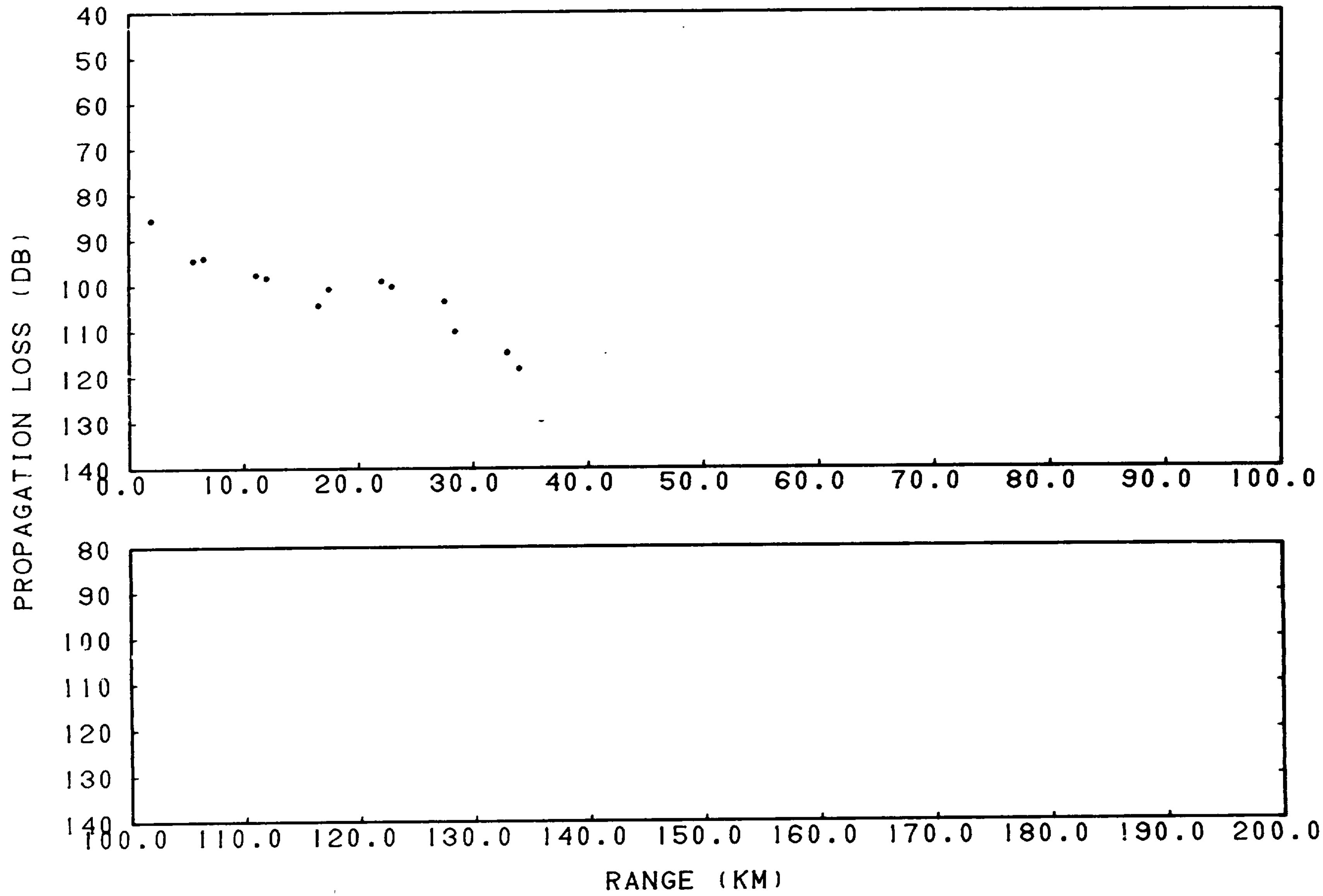
CONFIDENTIAL

(C) Figure IIG-17. Smoothed FASOR Station THORN, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



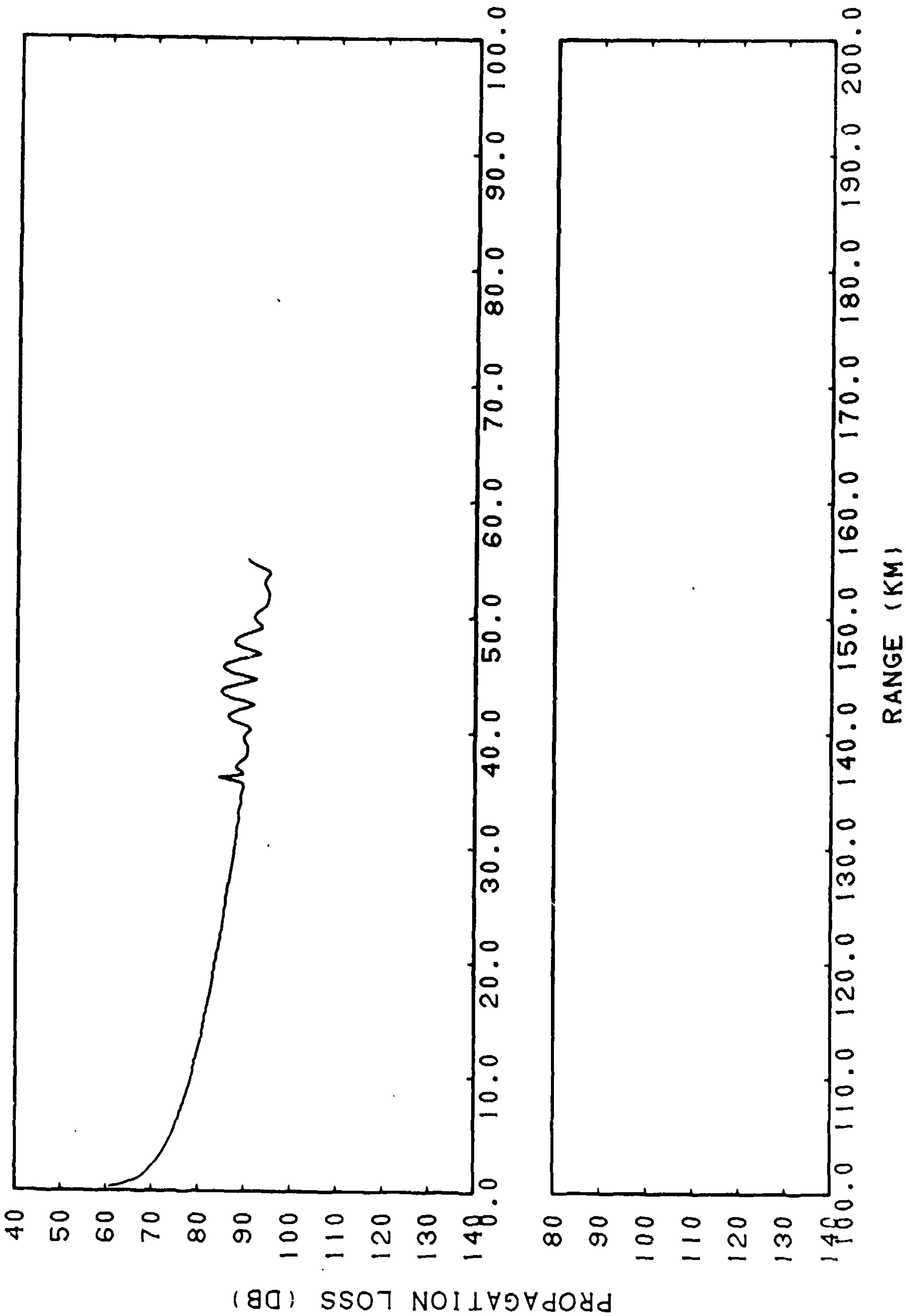
CONFIDENTIAL

(C) Figure IIG-18. Smoothed FASOR Station THORN, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



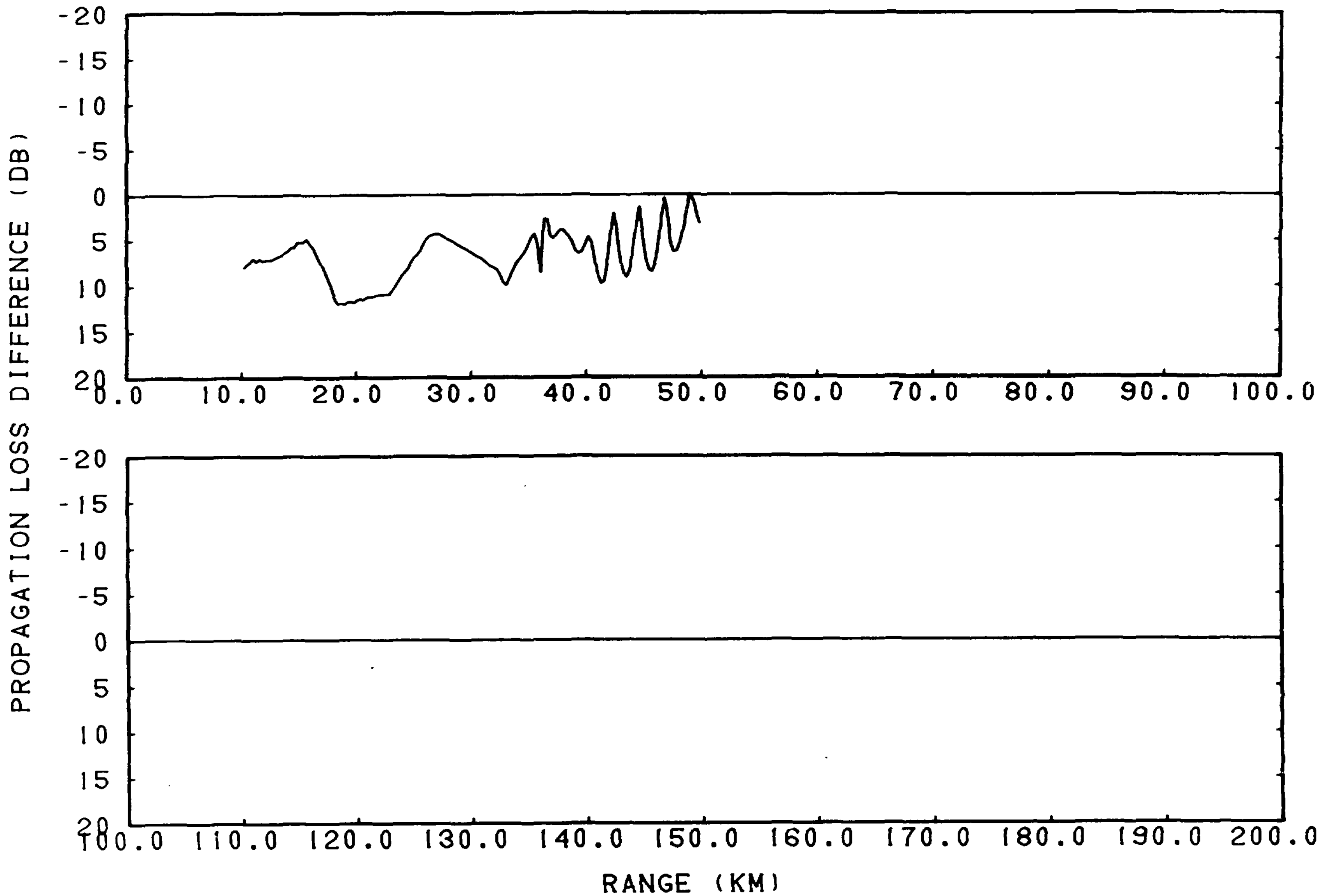
CONFIDENTIAL

(C) Figure IIG-19. Smoothed FASOR Station REDWOOD, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



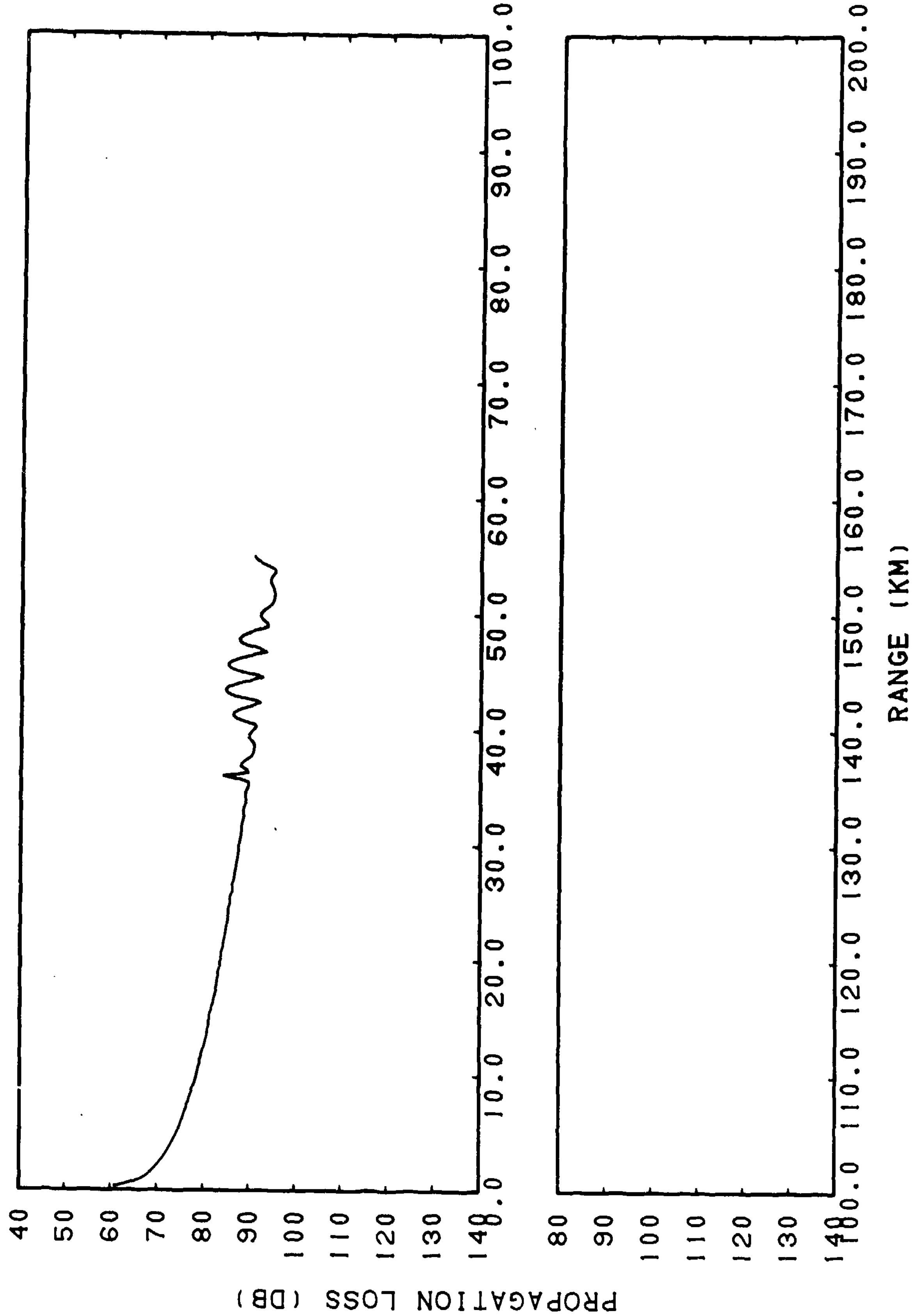
CONFIDENTIAL

(C) Figure IIG-20. FACT Coherent, Station FIG, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



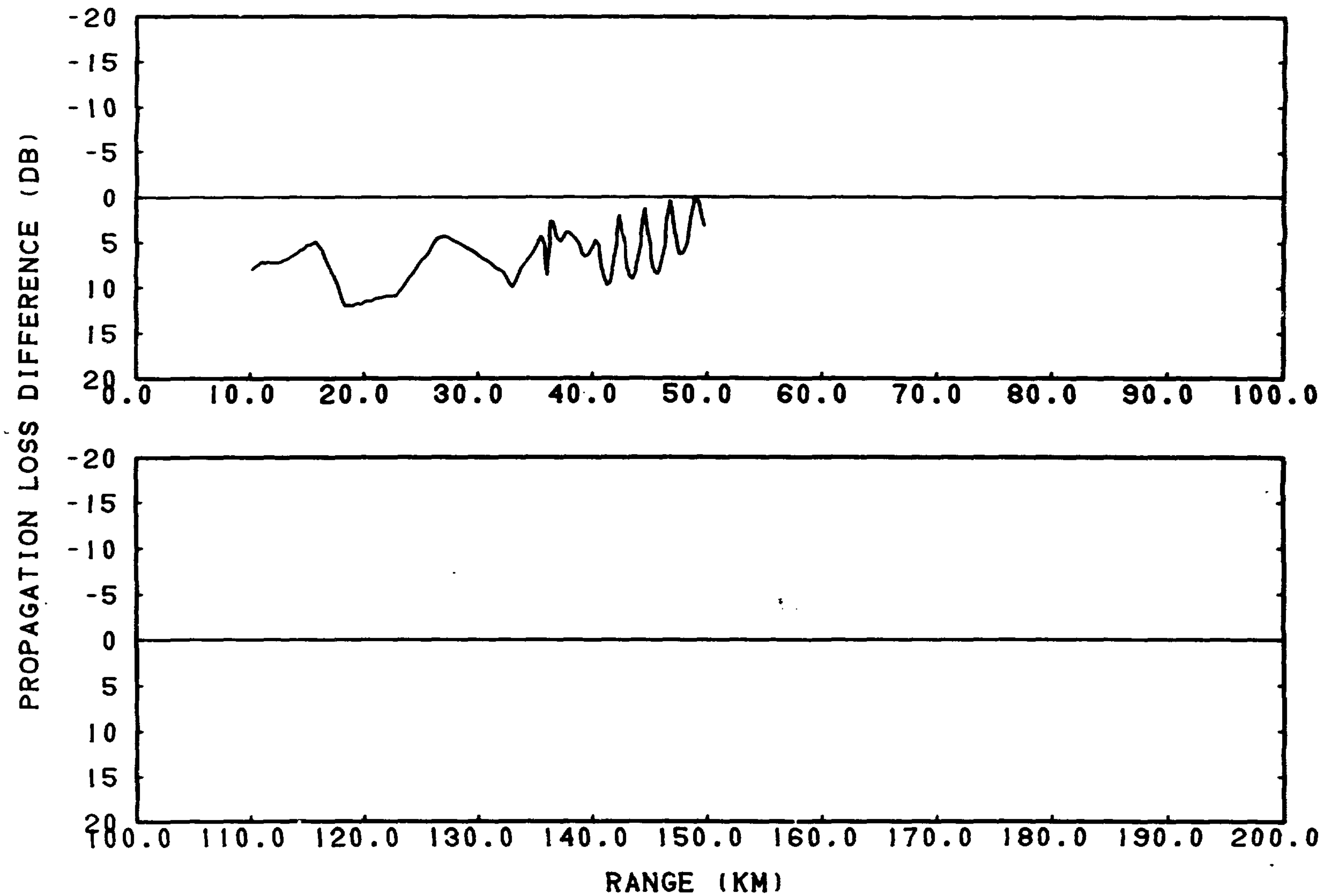
CONFIDENTIAL

(C) Figure IIG-21. FACT Coherent, Station FIG, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station FIG, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



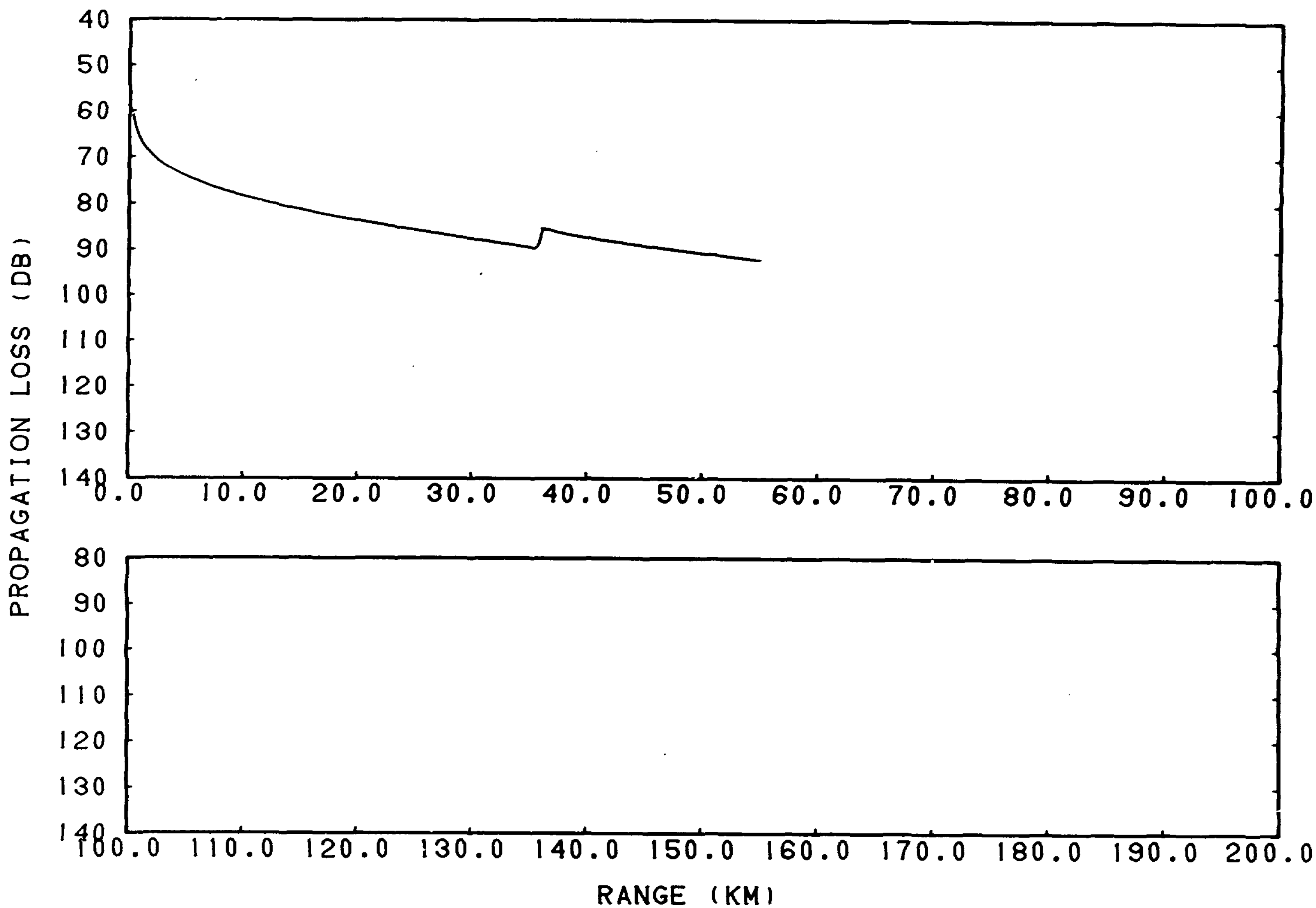
CONFIDENTIAL

(C) Figure IIG-22. FACT Semi-coherent, Station FIG, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



CONFIDENTIAL

(C) Figure IIG-23. FACT Semi-coherent, Station FIG, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station FIG, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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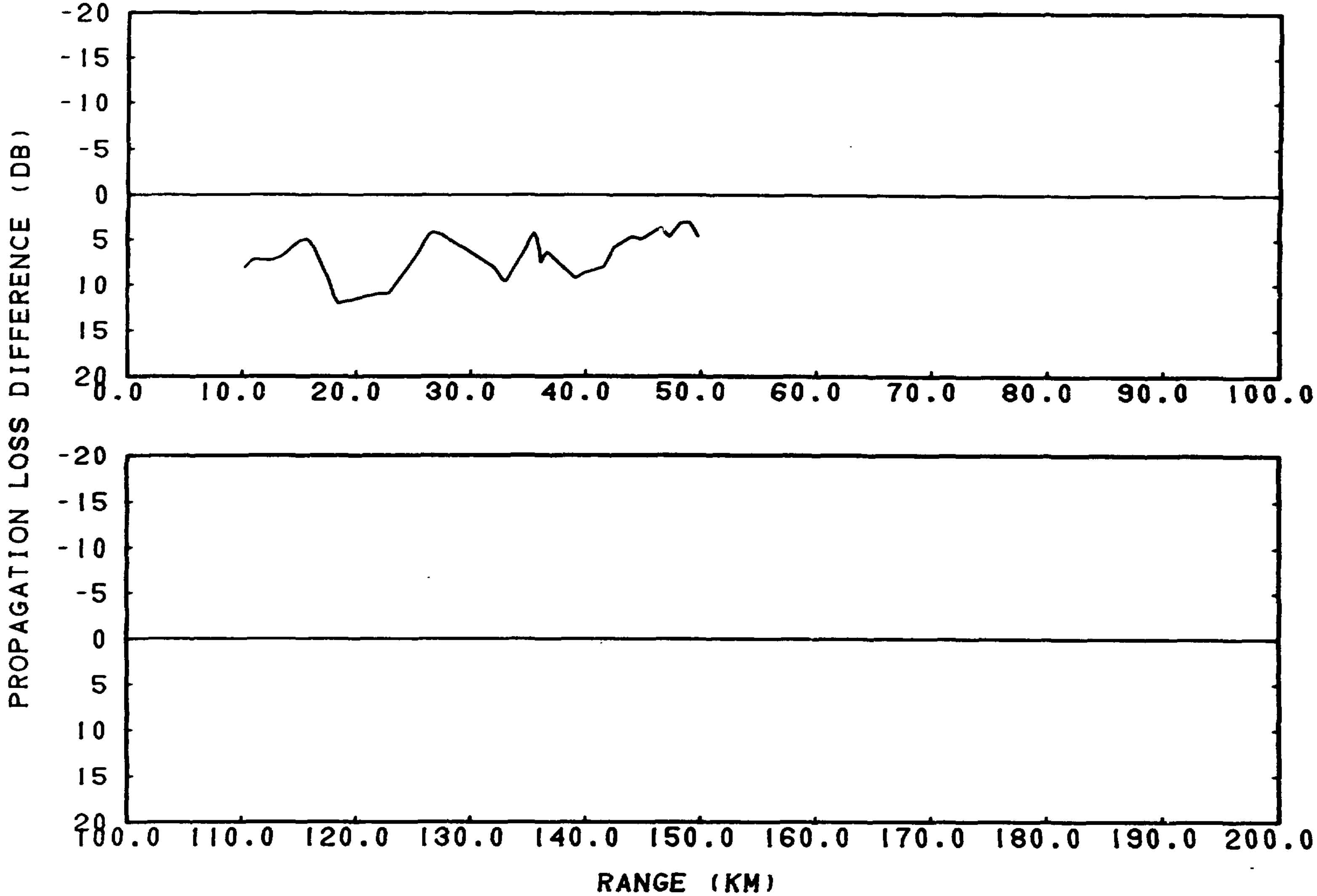
(C) Figure IIG-24. FACT Incoherent, Station FIG, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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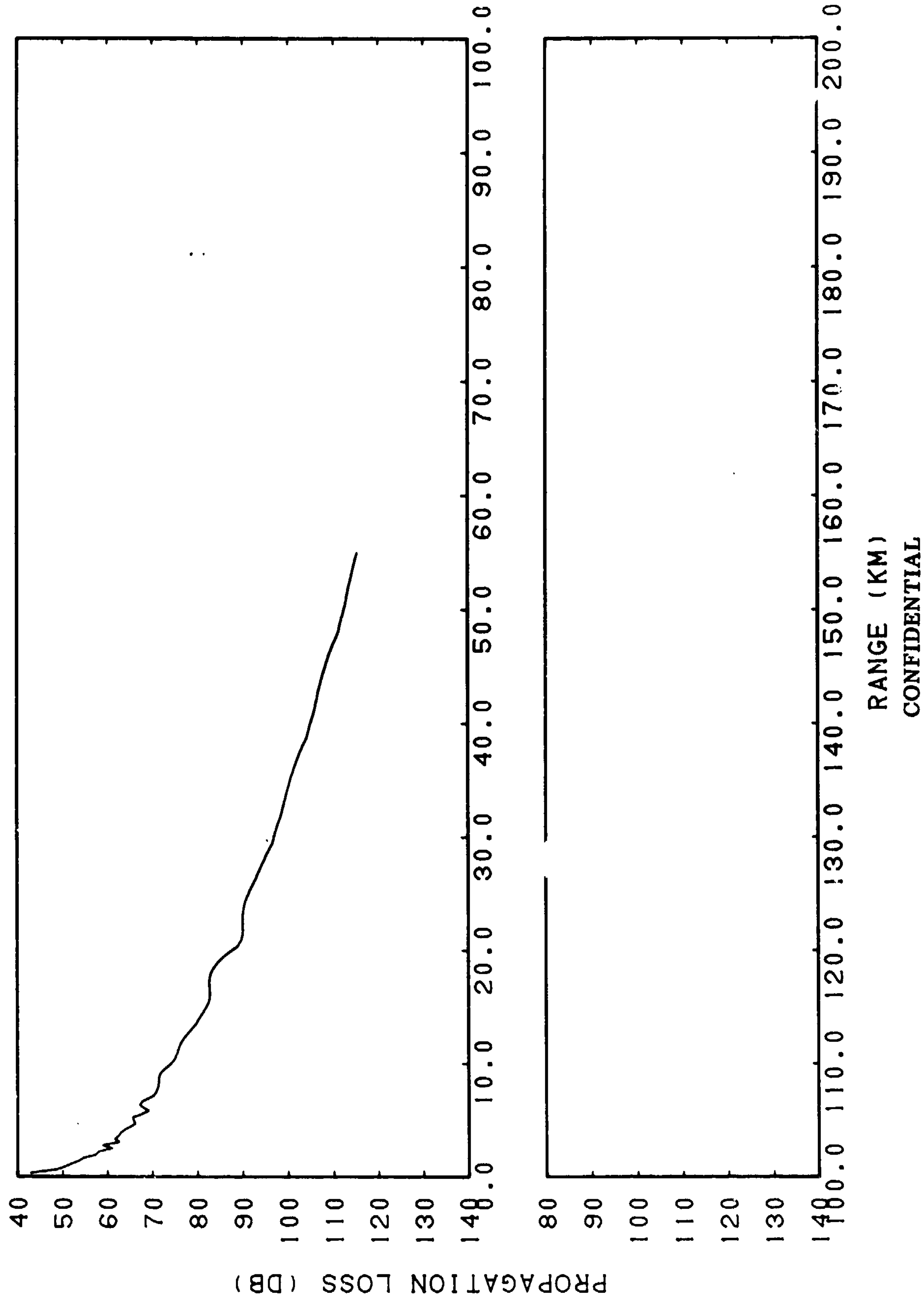
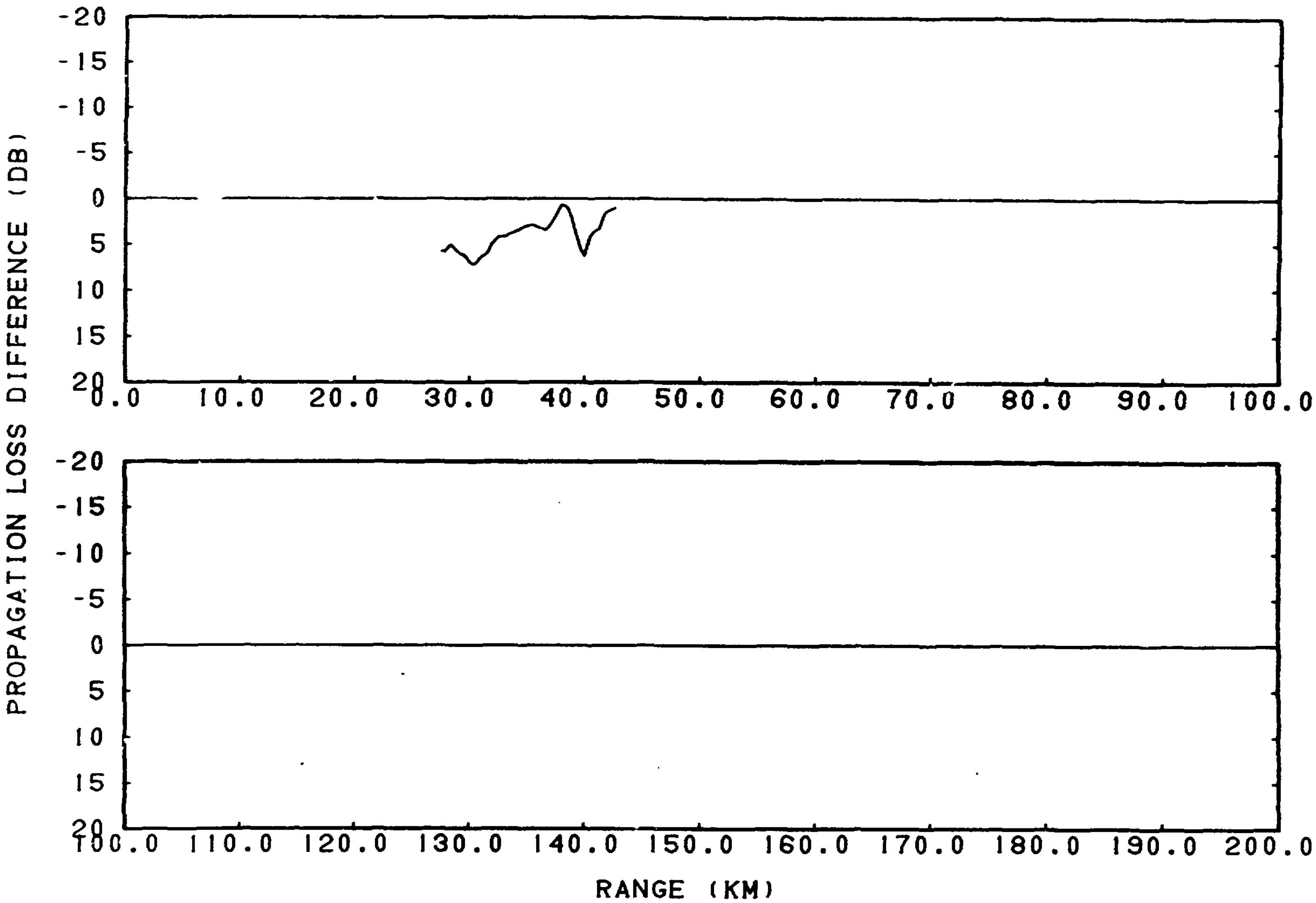
(C) Figure IIG-25. FACT Incoherent, Station FIG, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station FIG, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz

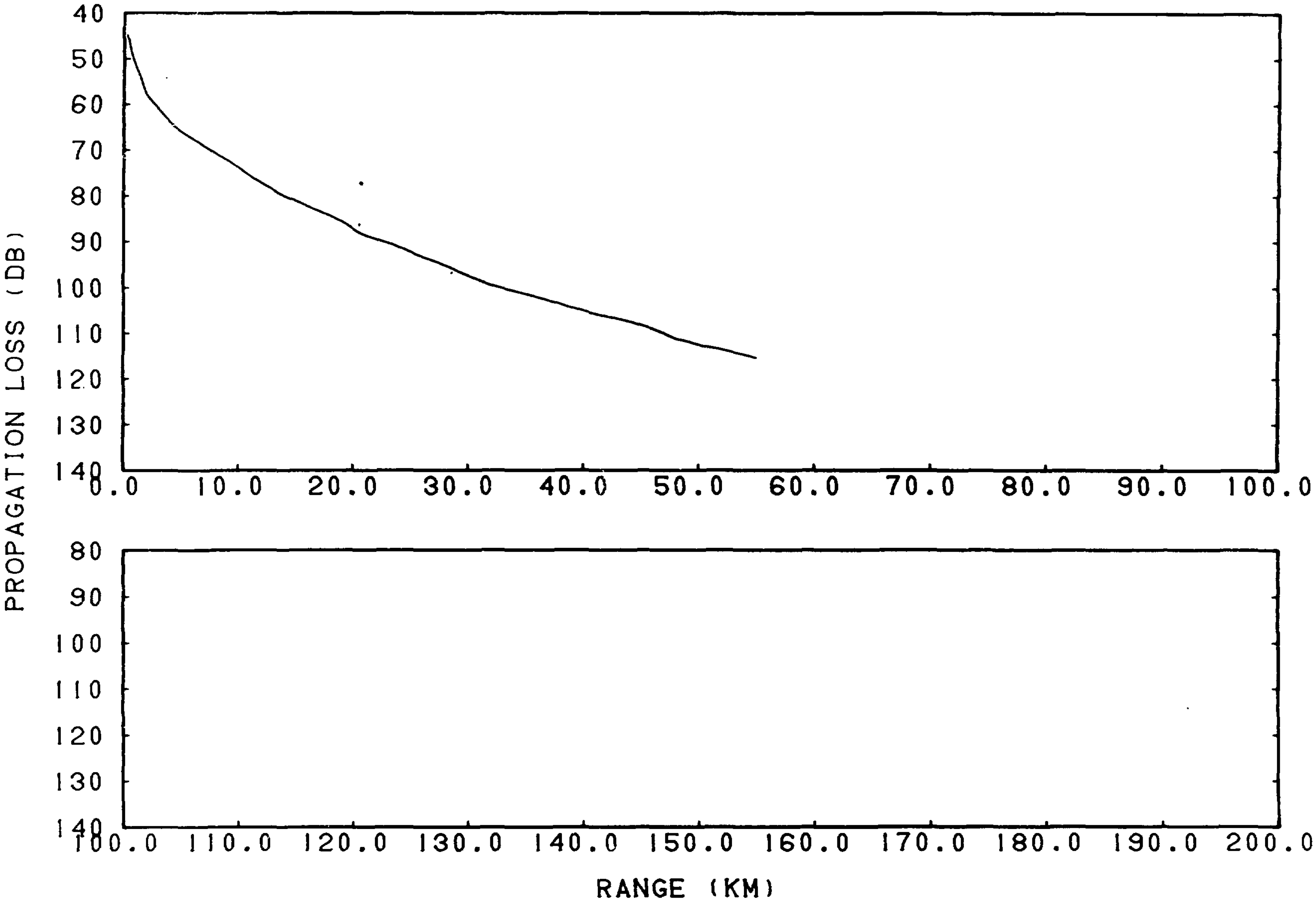


(C) Figure IIG-26. FACT Coherent, Station OAK, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



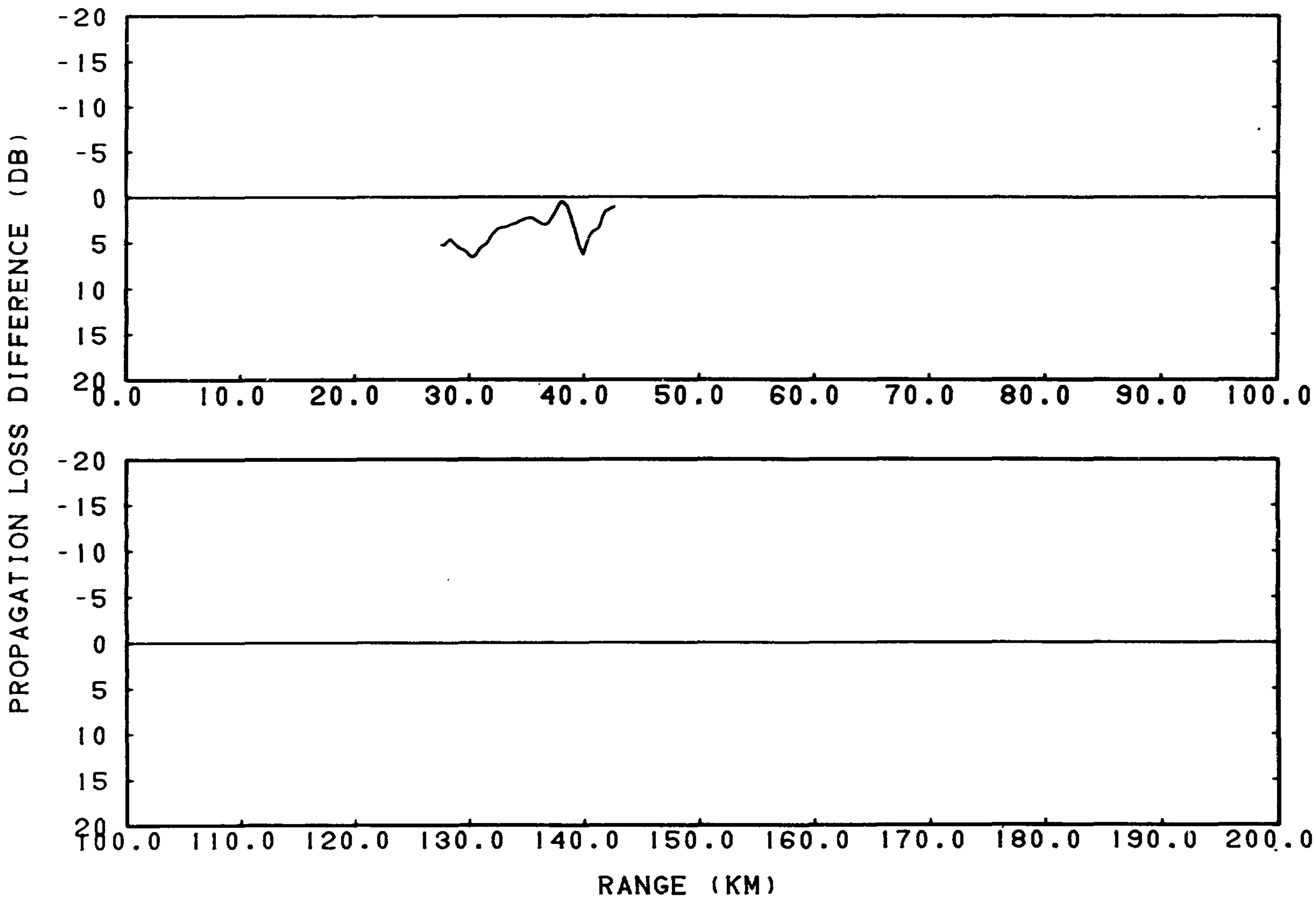
CONFIDENTIAL

(C) Figure IIG-27. FACT Coherent, Station OAK, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 15.0 Hertz, Subtracted from Smoothed FASOR, Station OAK, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



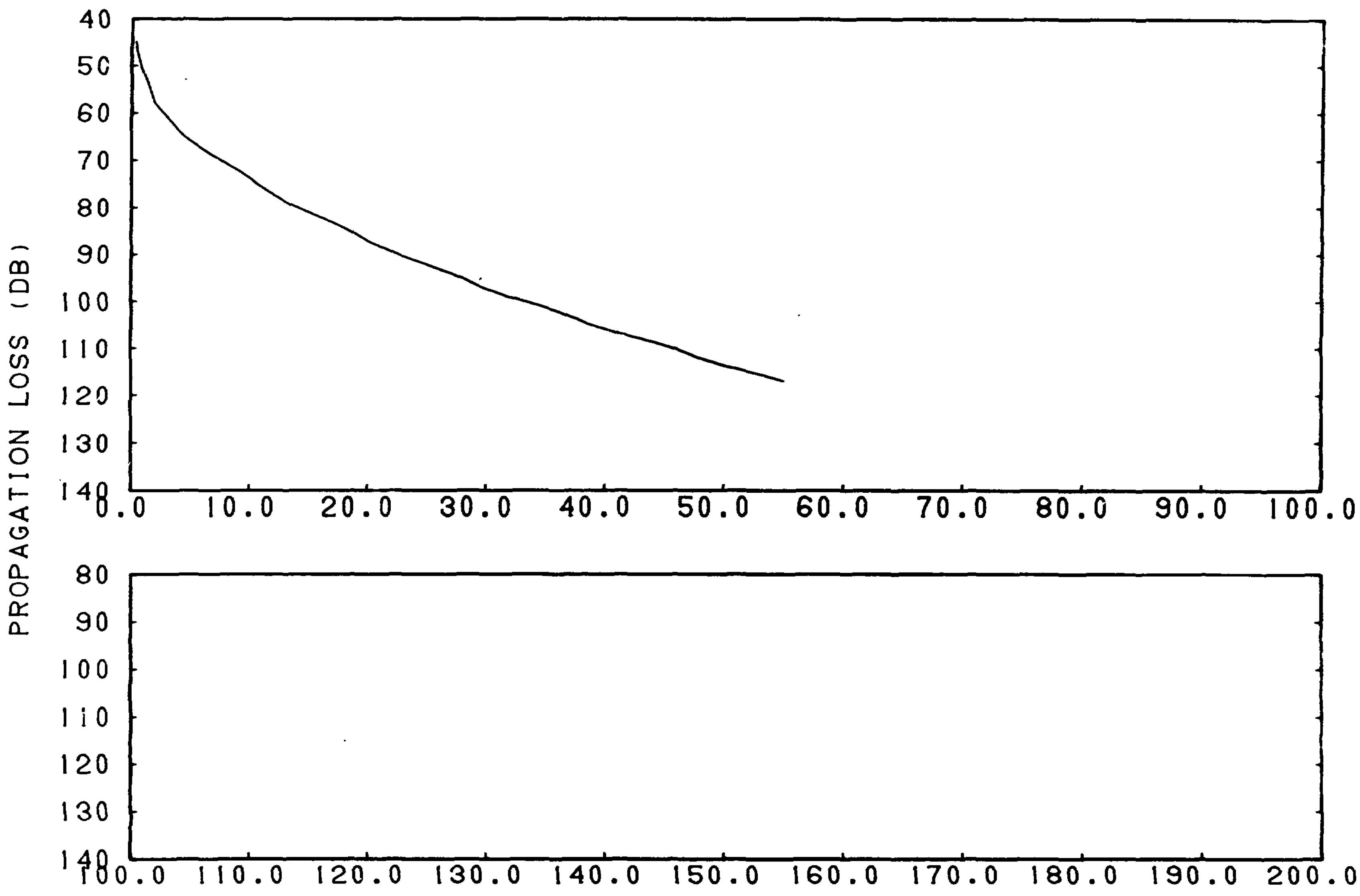
CONFIDENTIAL

(C) Figure IIG-28. FACT Semi-coherent, Station OAK, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



CONFIDENTIAL

(C) Figure IIG-29. FACT Semi-coherent, Station OAK, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station OAK, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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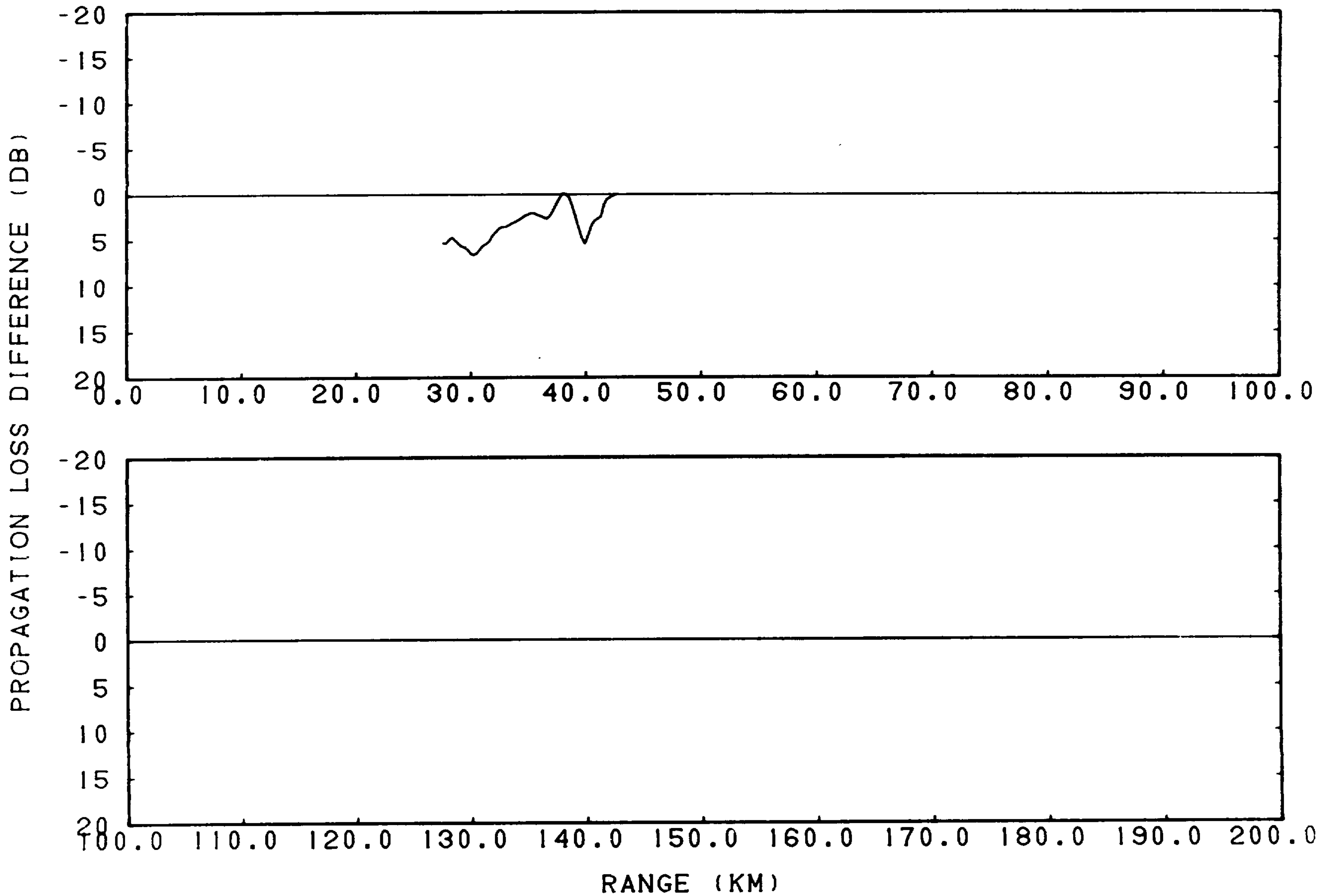
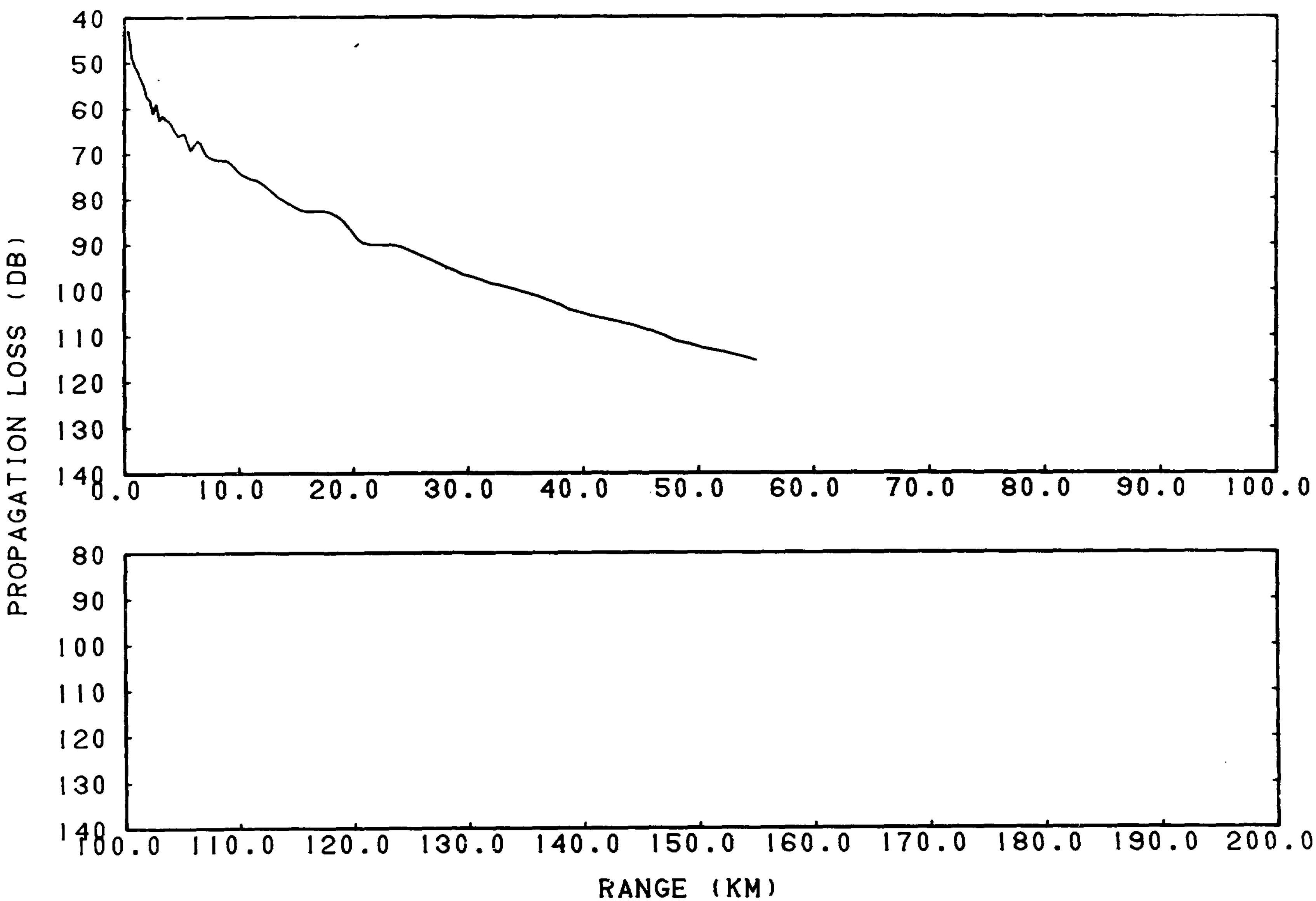
(C) Figure IIG-30. FACT Incoherent, Station OAK, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



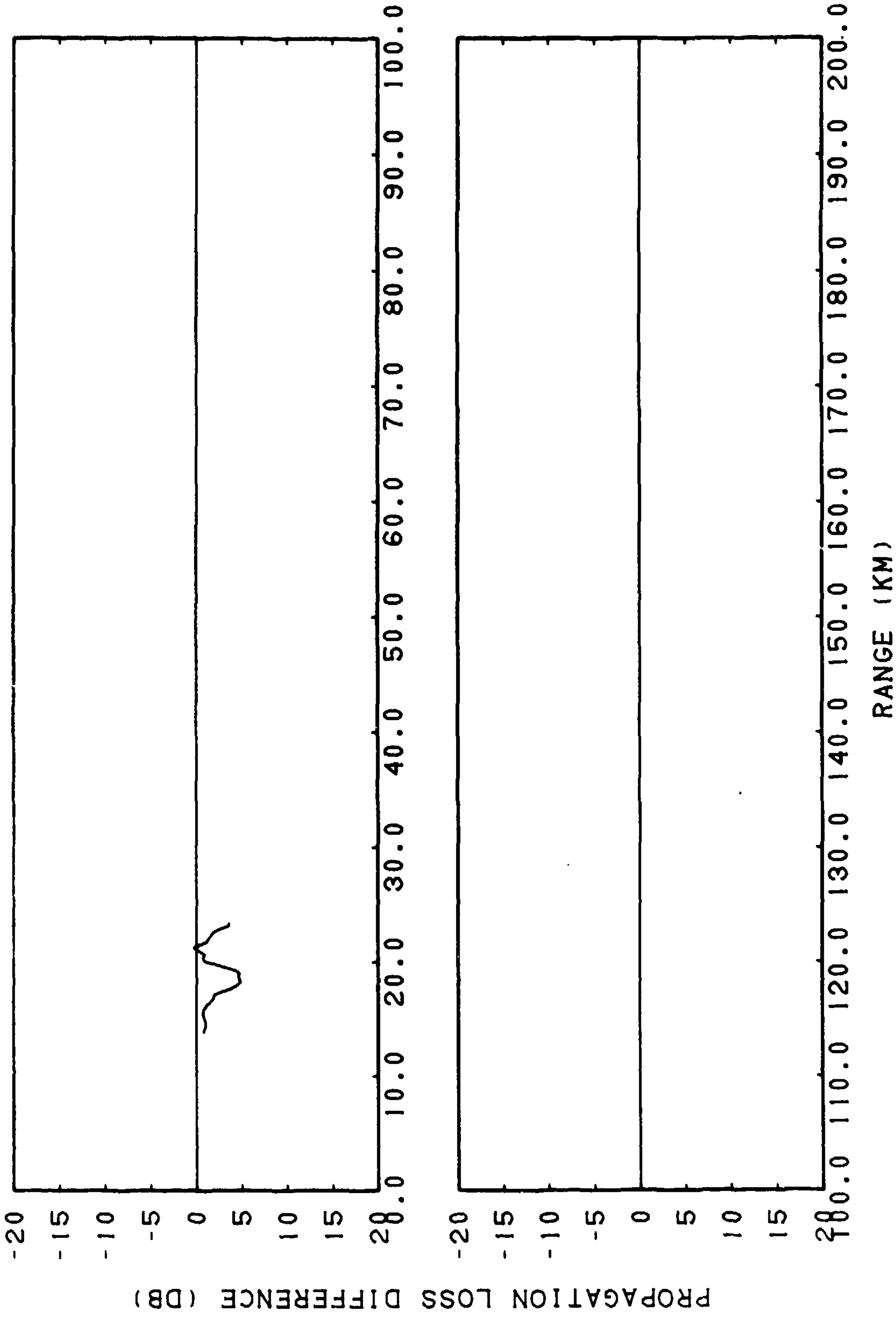
CONFIDENTIAL

(C) Figure IIG-31. FACT Incoherent, Station OAK, Run 1, Source Depth = 23 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station OAK, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



CONFIDENTIAL

(C) Figure IIG-32. FACT Coherent, Station OAK, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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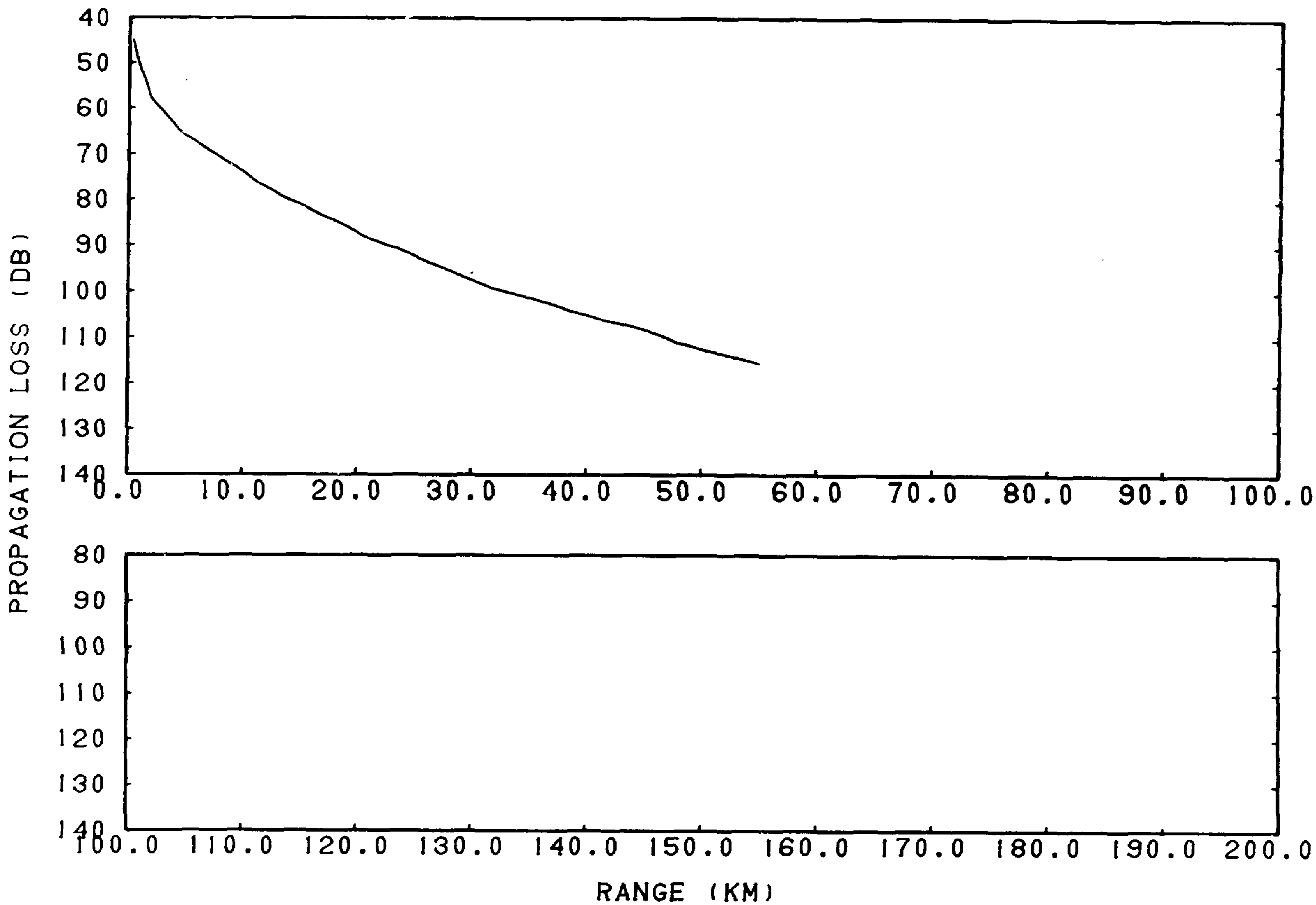
(C) Figure IIG-33. FACT Coherent, Station OAK, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station OAK, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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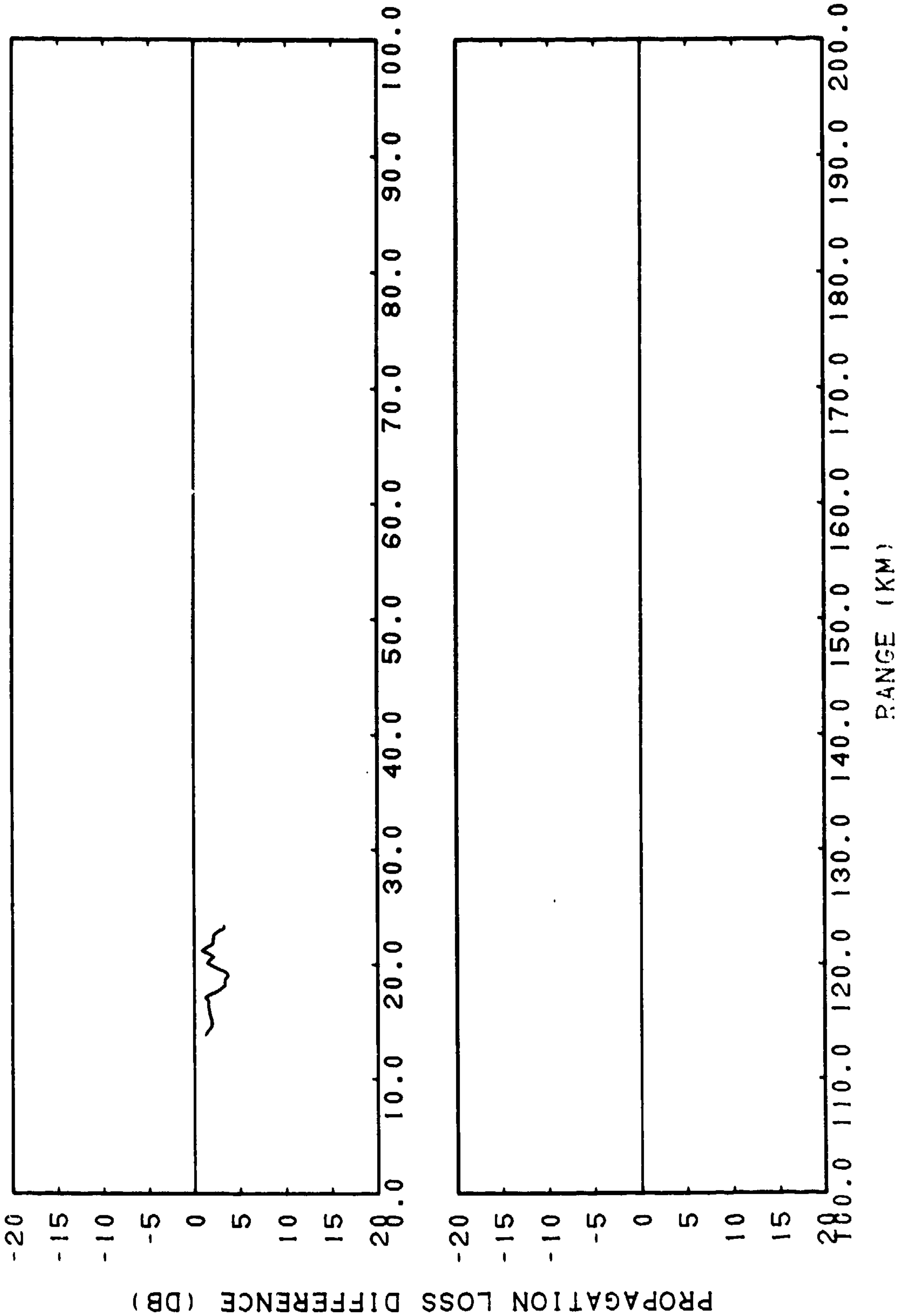
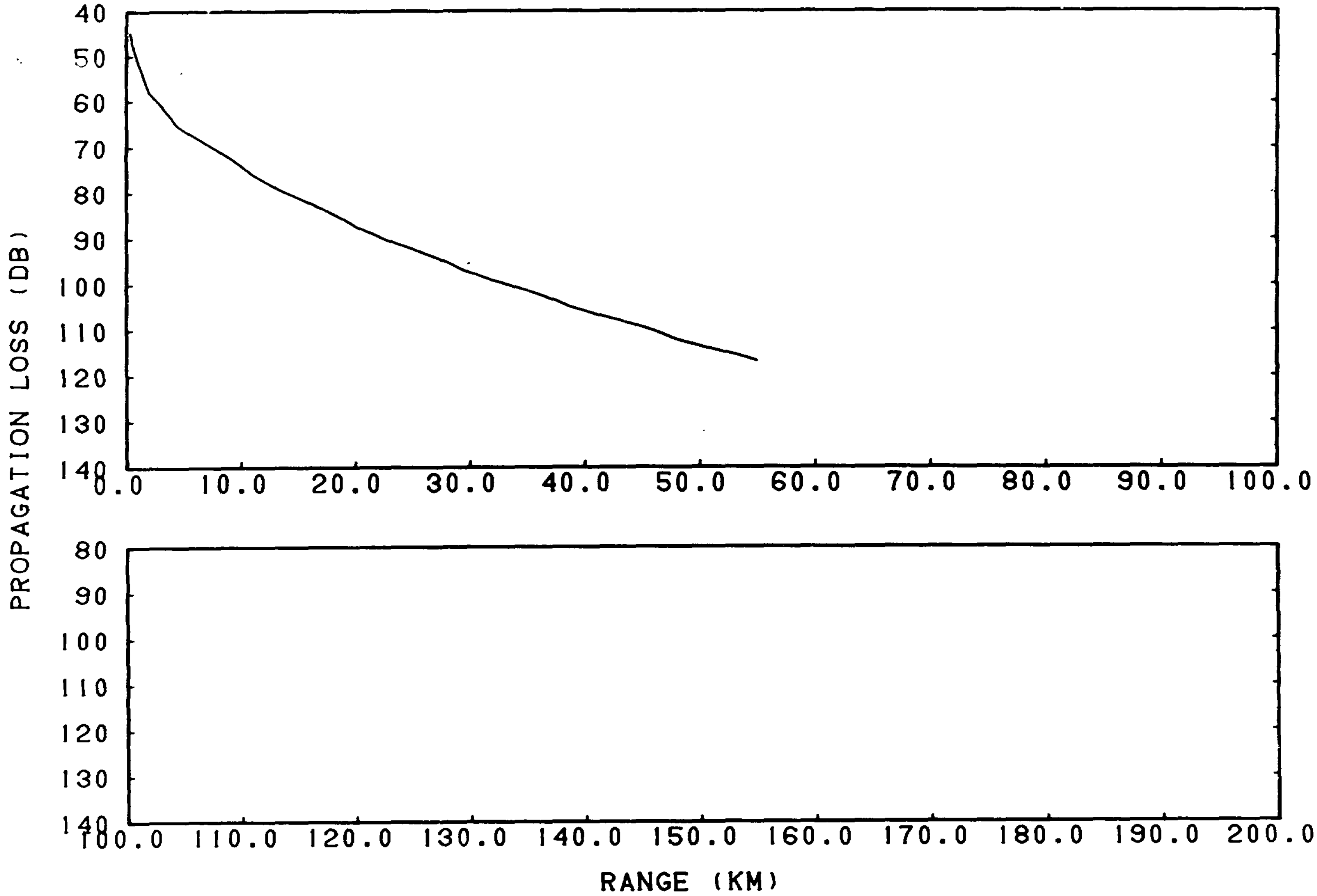
(C) Figure IIG-34. FACT Semi-coherent, Station OAK, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



CONFIDENTIAL

(C) Figure IIG-35. FACT Semi-coherent, Station OAK, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station OAK, Run 2, Source Depth = 37 Meters, Frequency = 1500 Hertz



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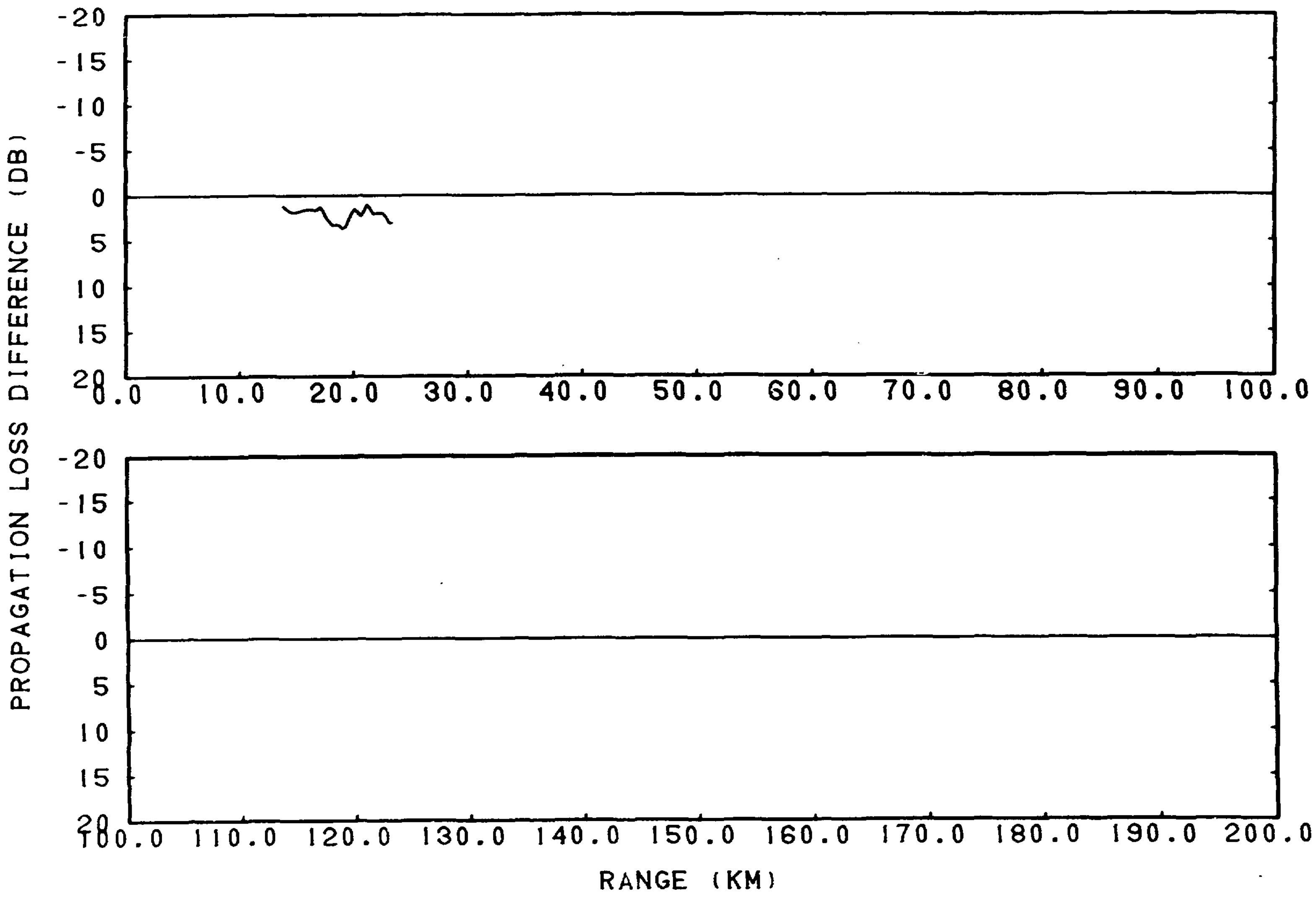
(C) Figure IIG-36. FACT Incoherent, Station OAK, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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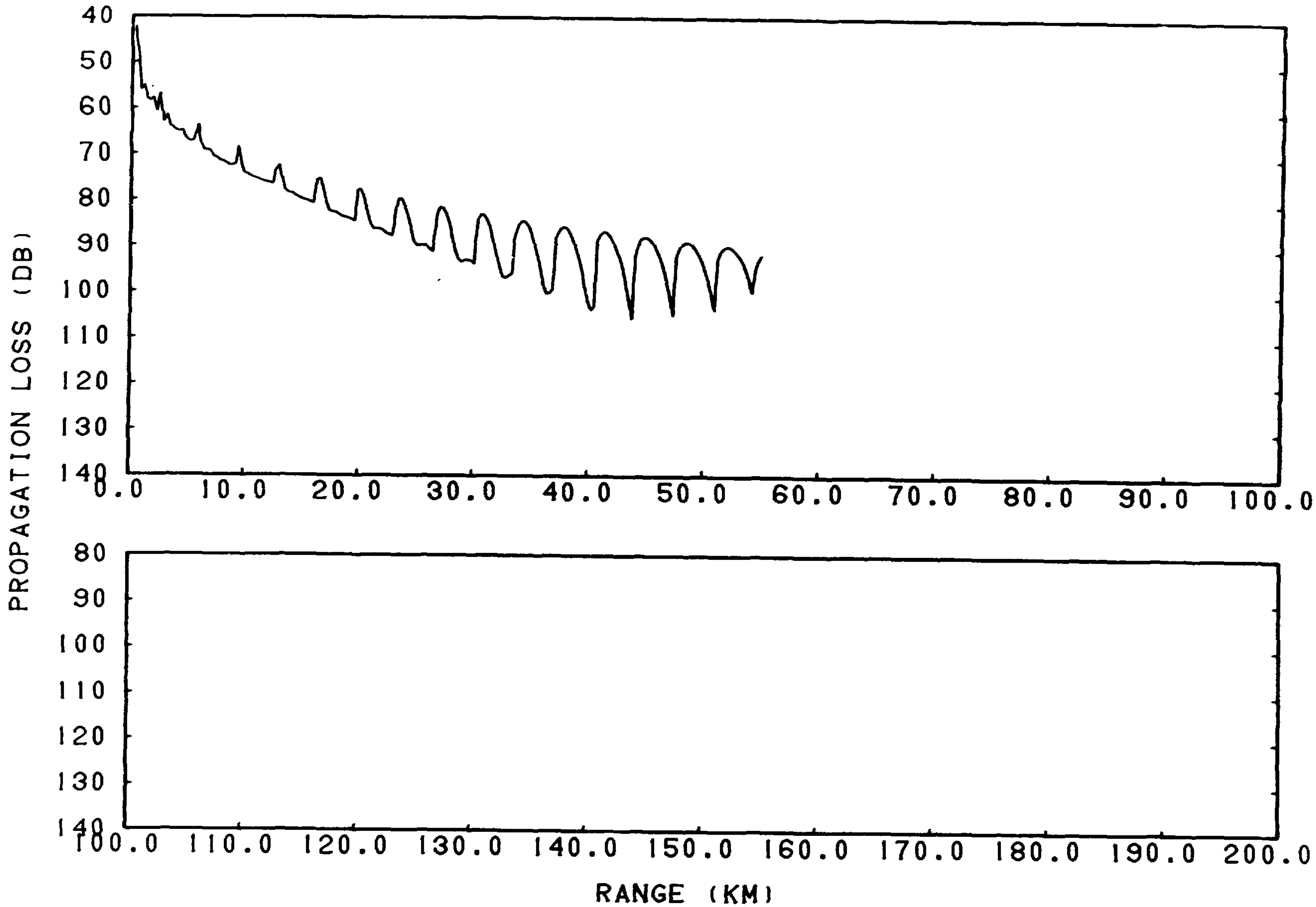
(C) Figure IIG-37. FACT Incoherent, Station OAK, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station OAK, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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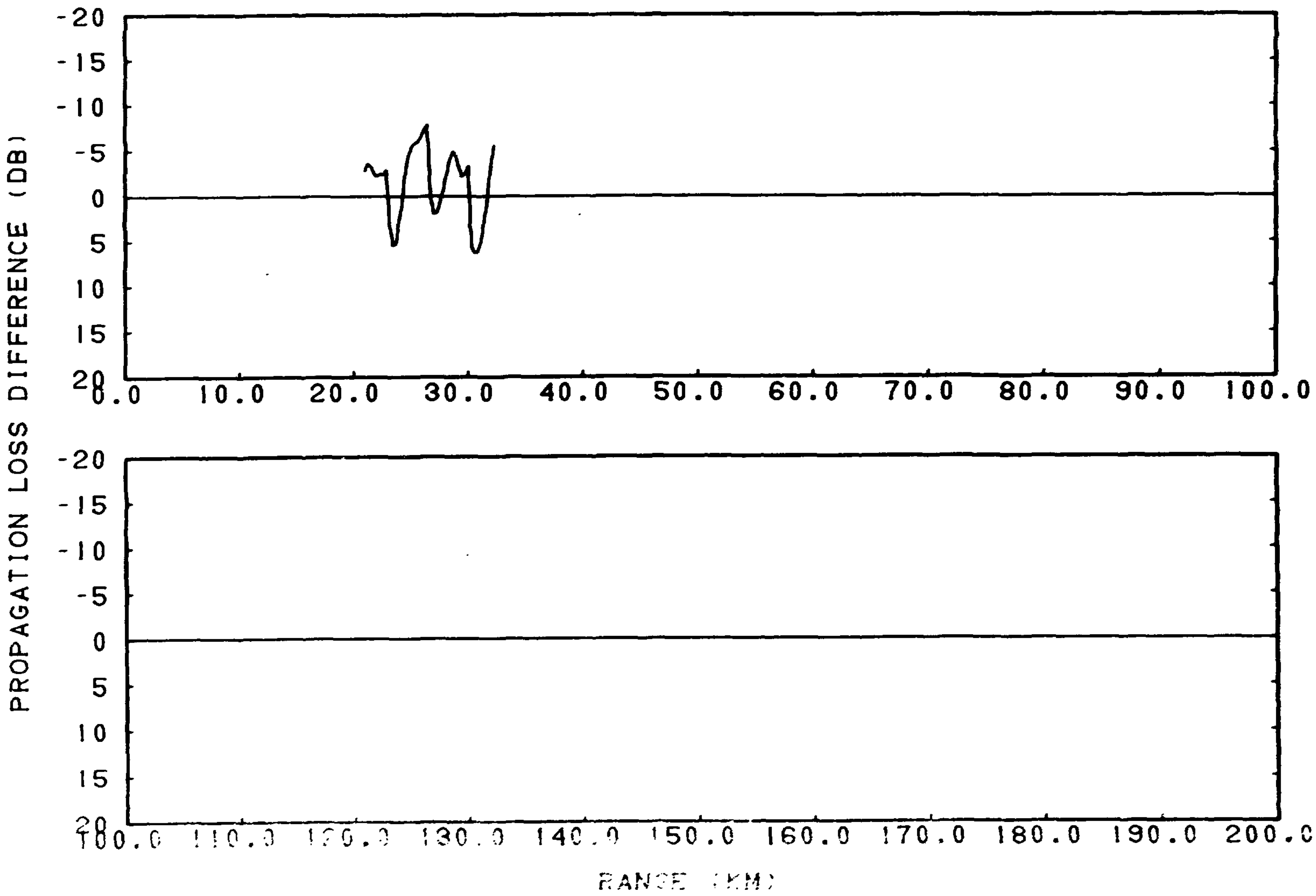
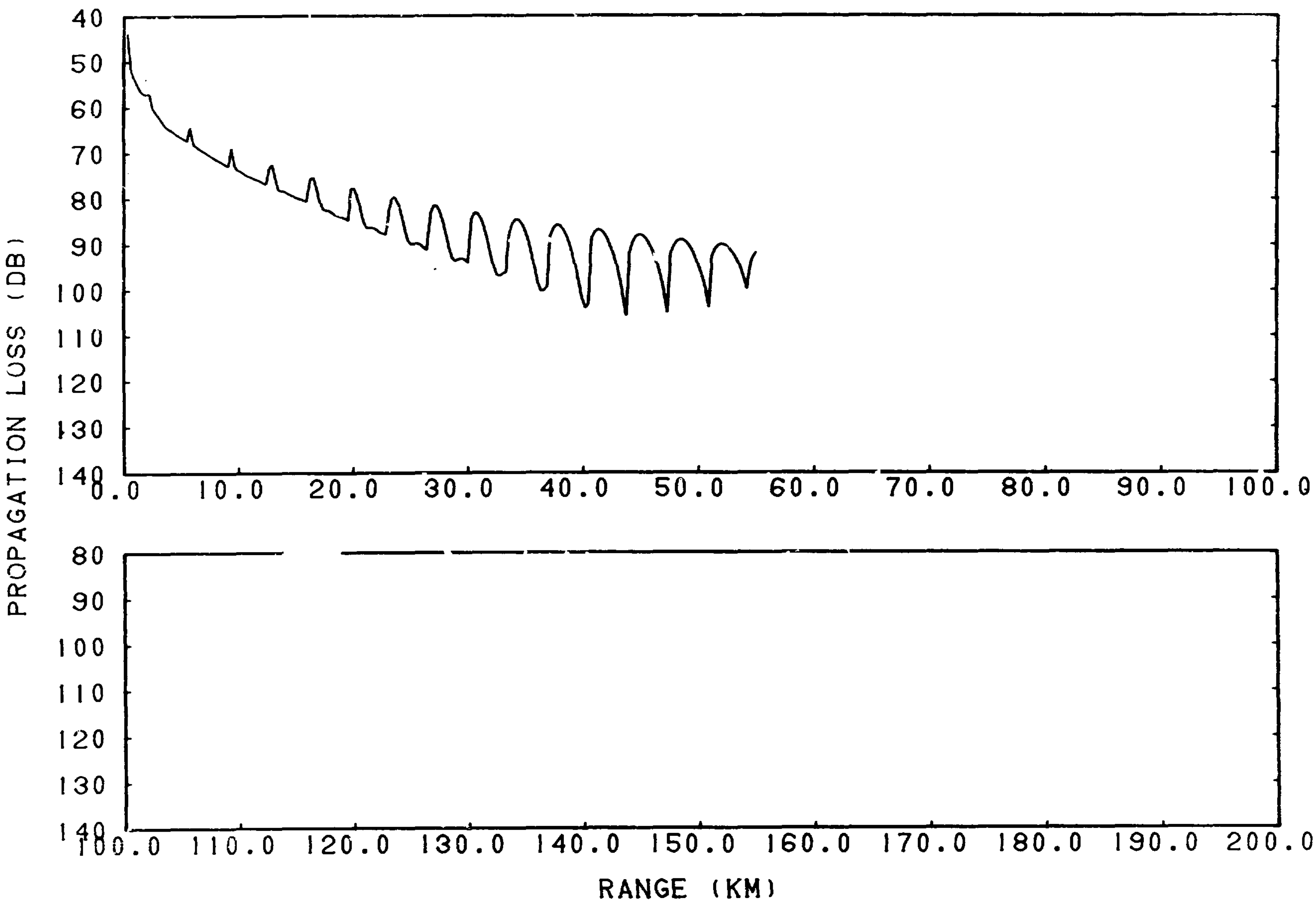
(C) Figure IIG-38. FACT Coherent, Station THORN, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



CONFIDENTIAL

(C) Figure IIG-39. FACT Coherent, Station THORN, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station THORN, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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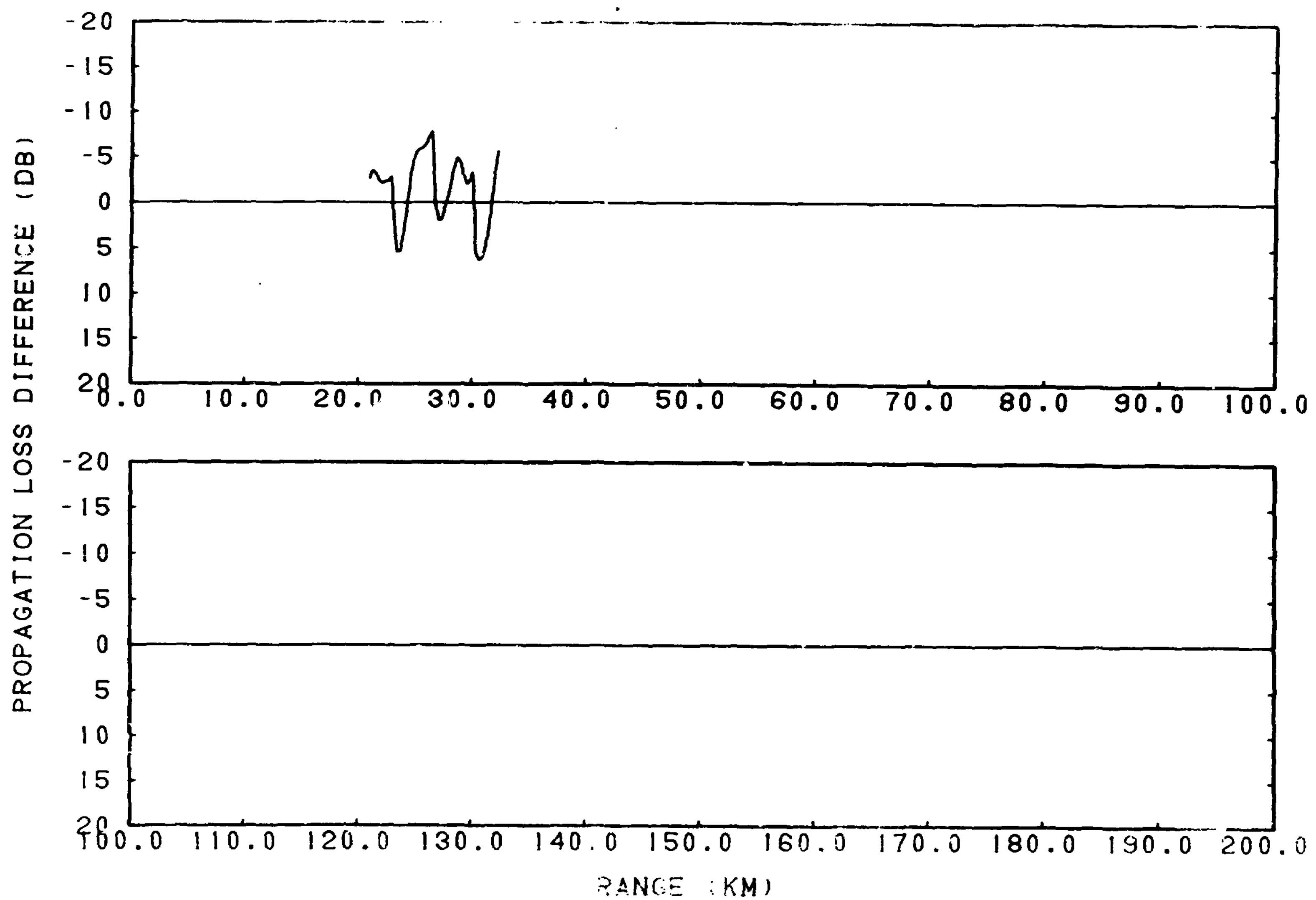
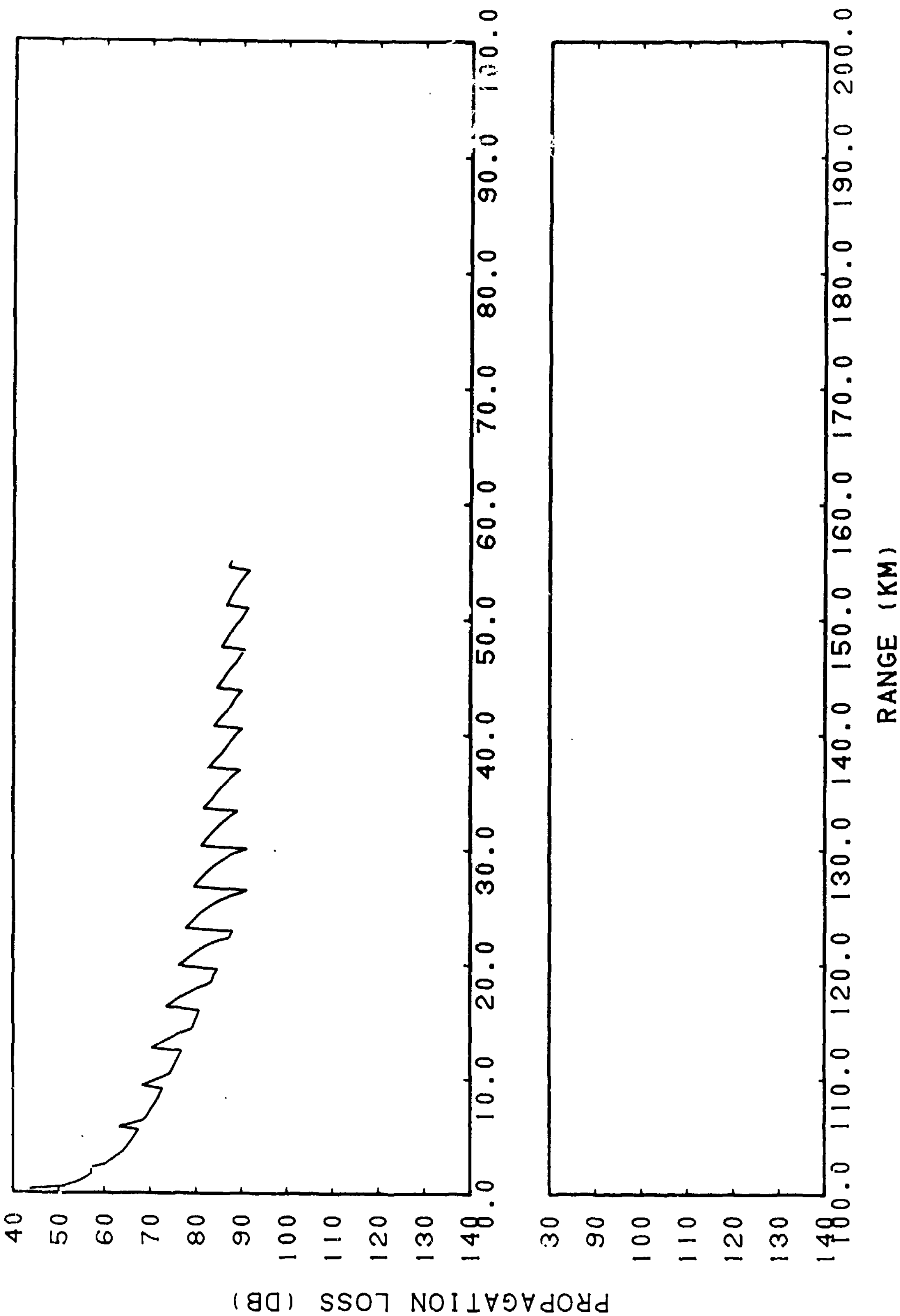
(C) Figure IIG-40. FACT Semi-coherent, Station THORN, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



CONFIDENTIAL

(C) Figure IIG-41. FACT Semi-coherent, Station THORN, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station THORN, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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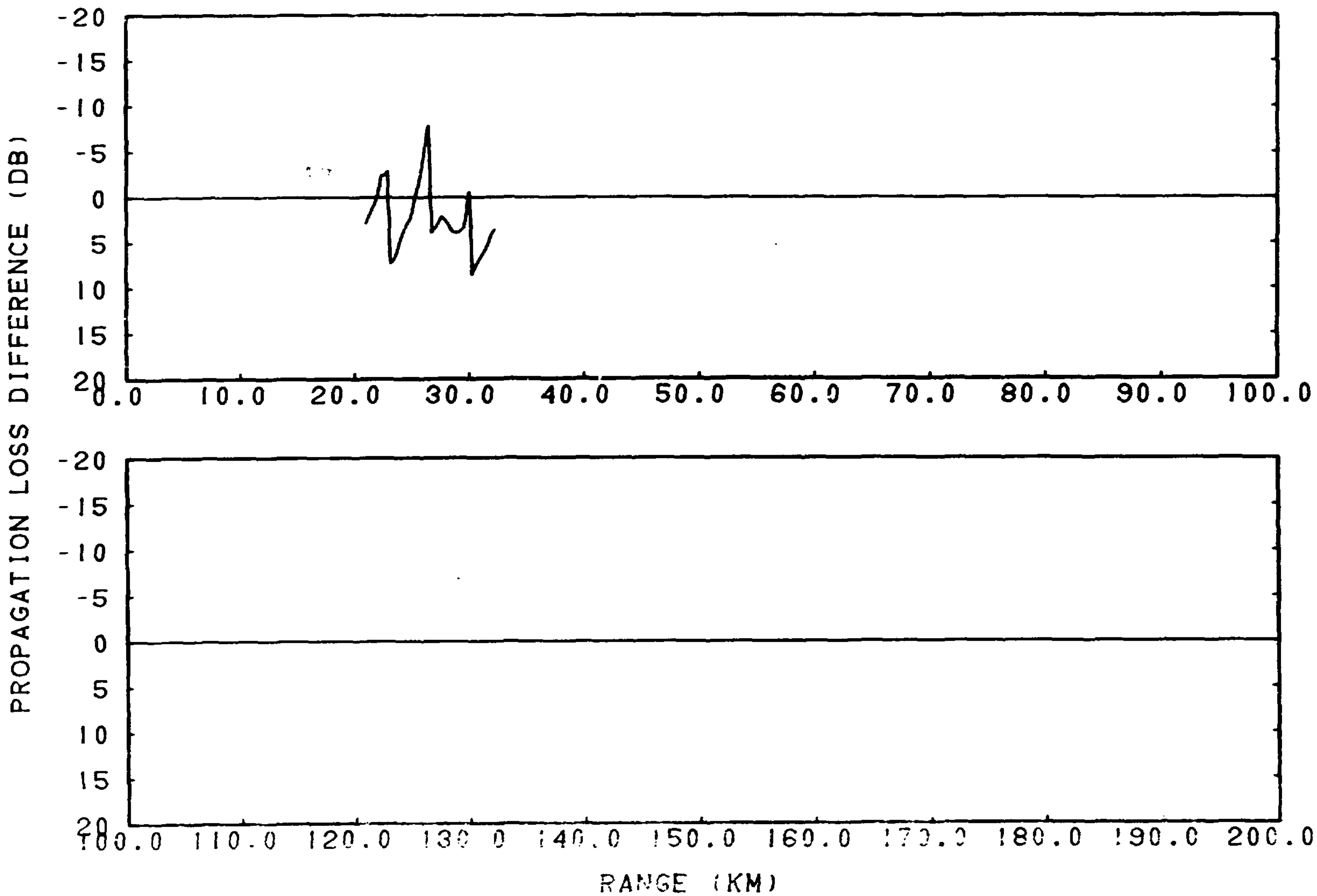
(C) Figure IIG-42. FACT Incoherent, Station THORN, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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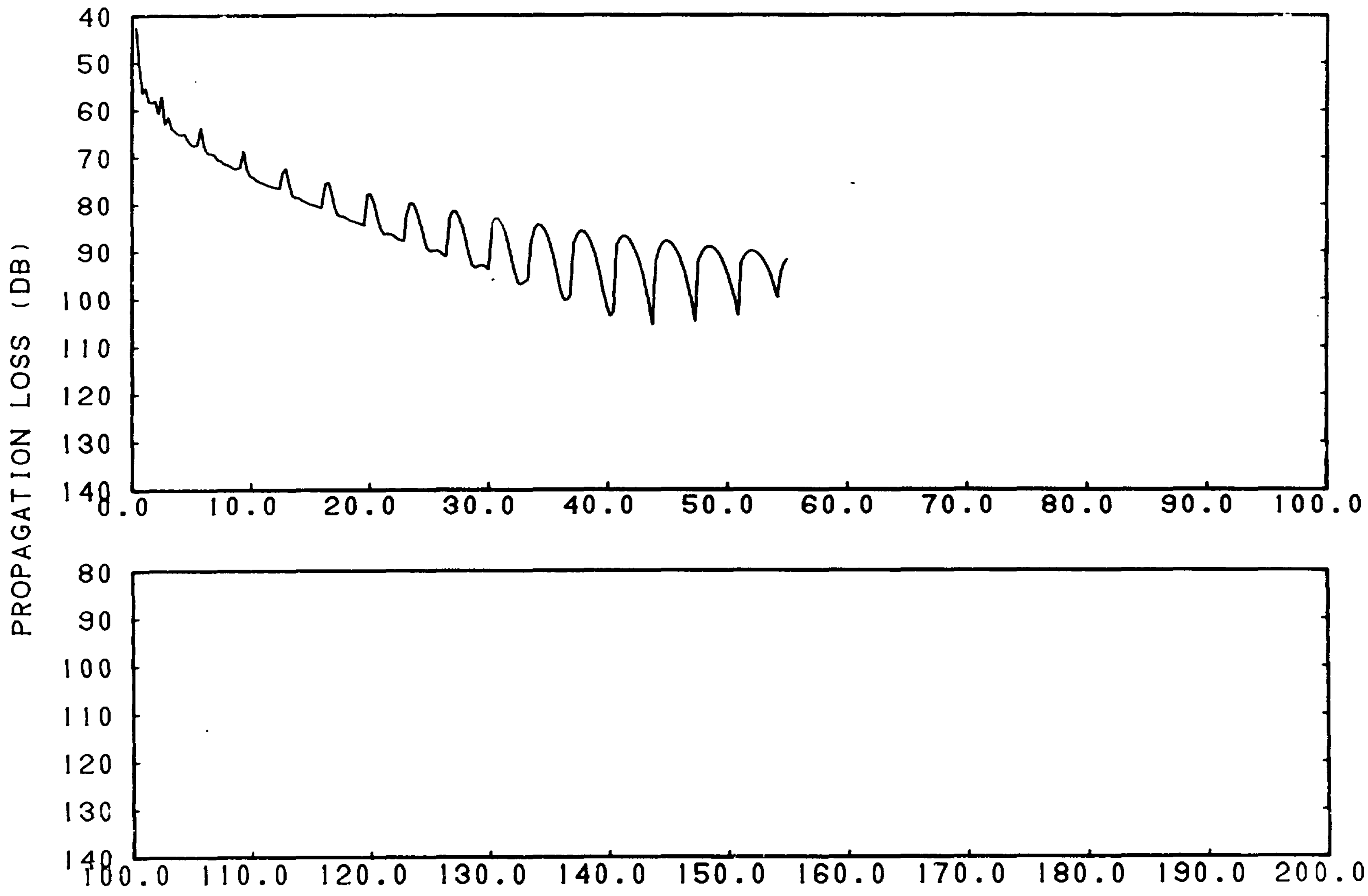
(C) Figure IIG-43. FACT Incoherent, Station THORN, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station THORN, Run 1, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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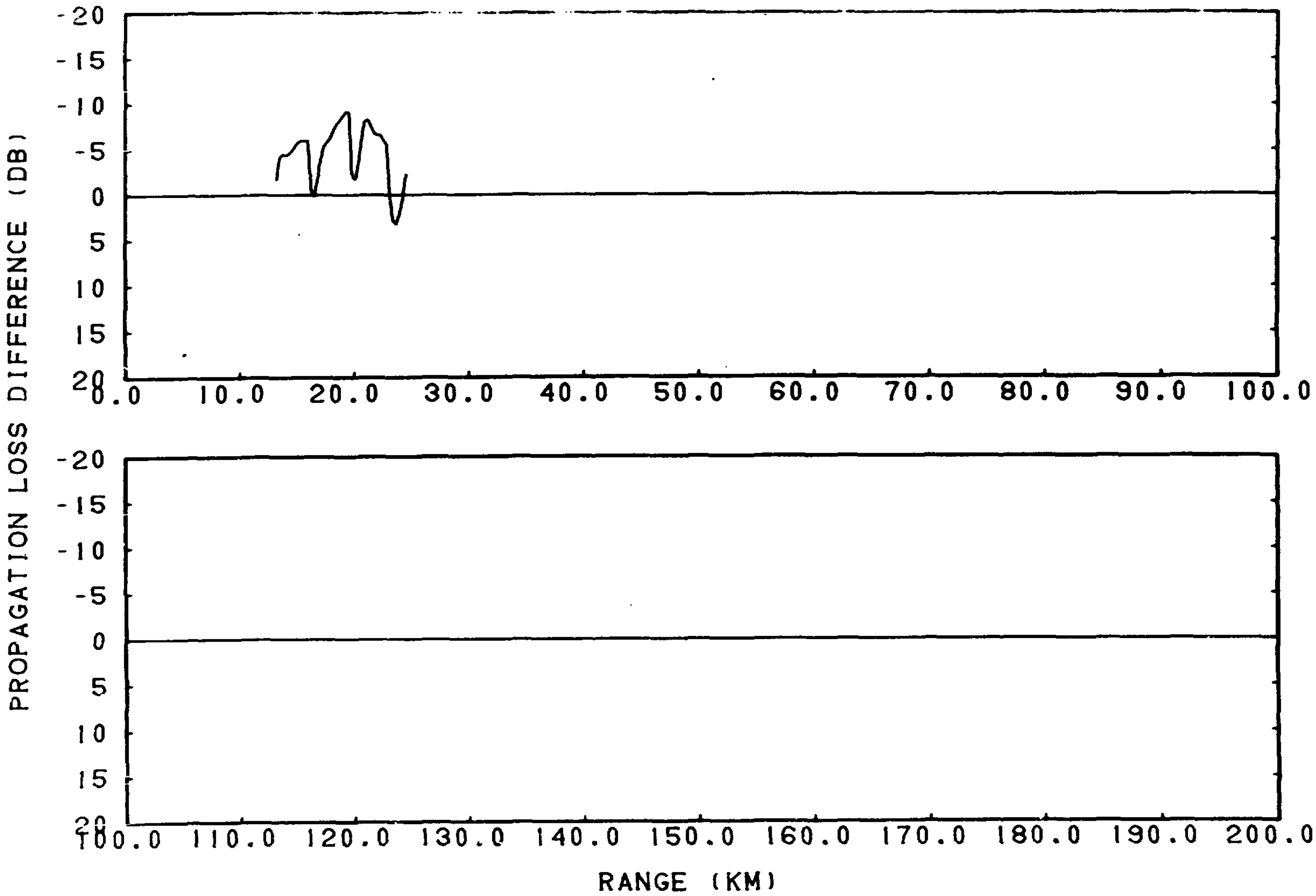
(C) Figure IIG-44. FACT Coherent, Station THORN, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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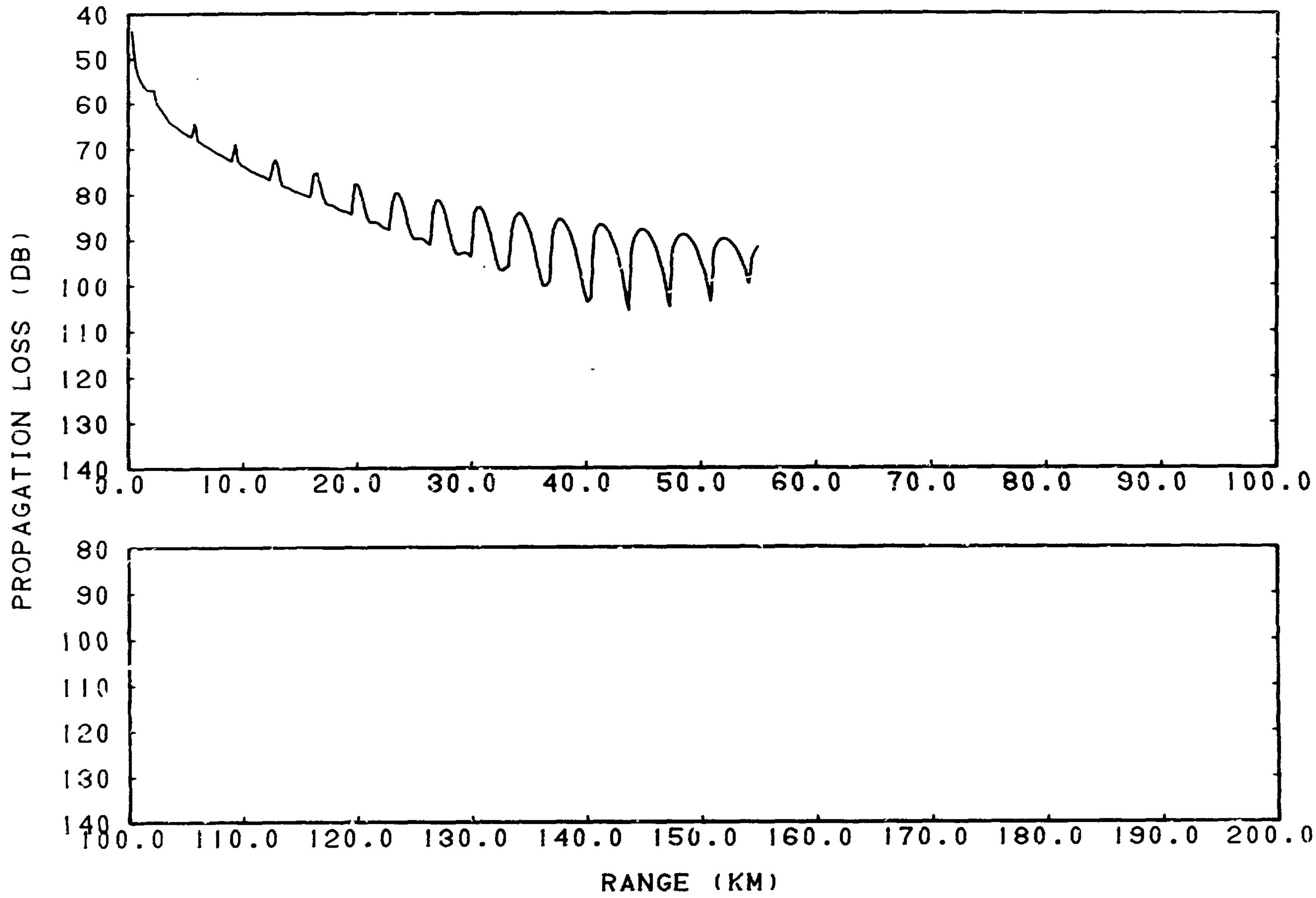
(C) Figure IIG-45. FACT Coherent, Station THORN, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station THORN, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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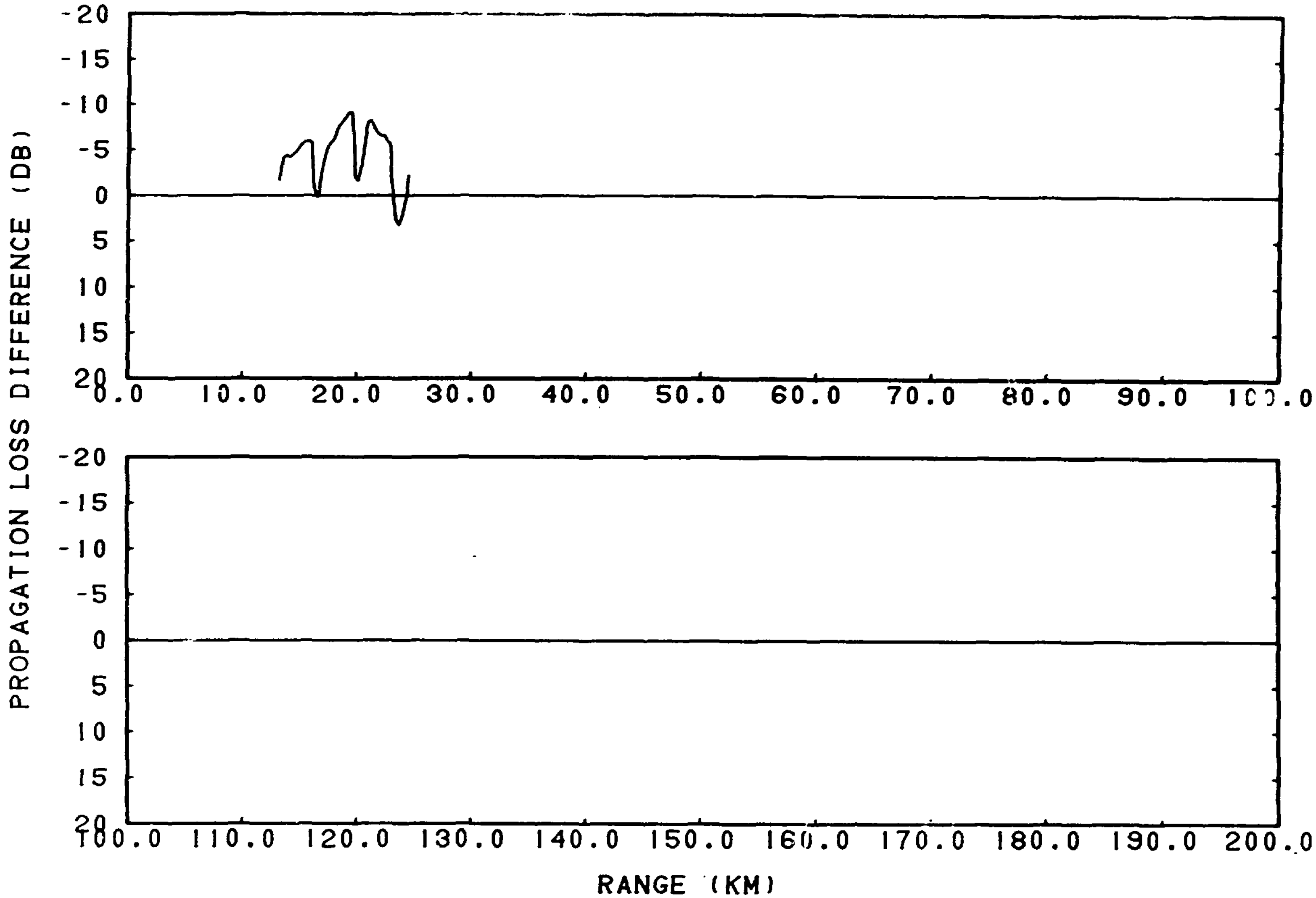
(C) Figure IIG-46. FACT Semi-coherent, Station THORN, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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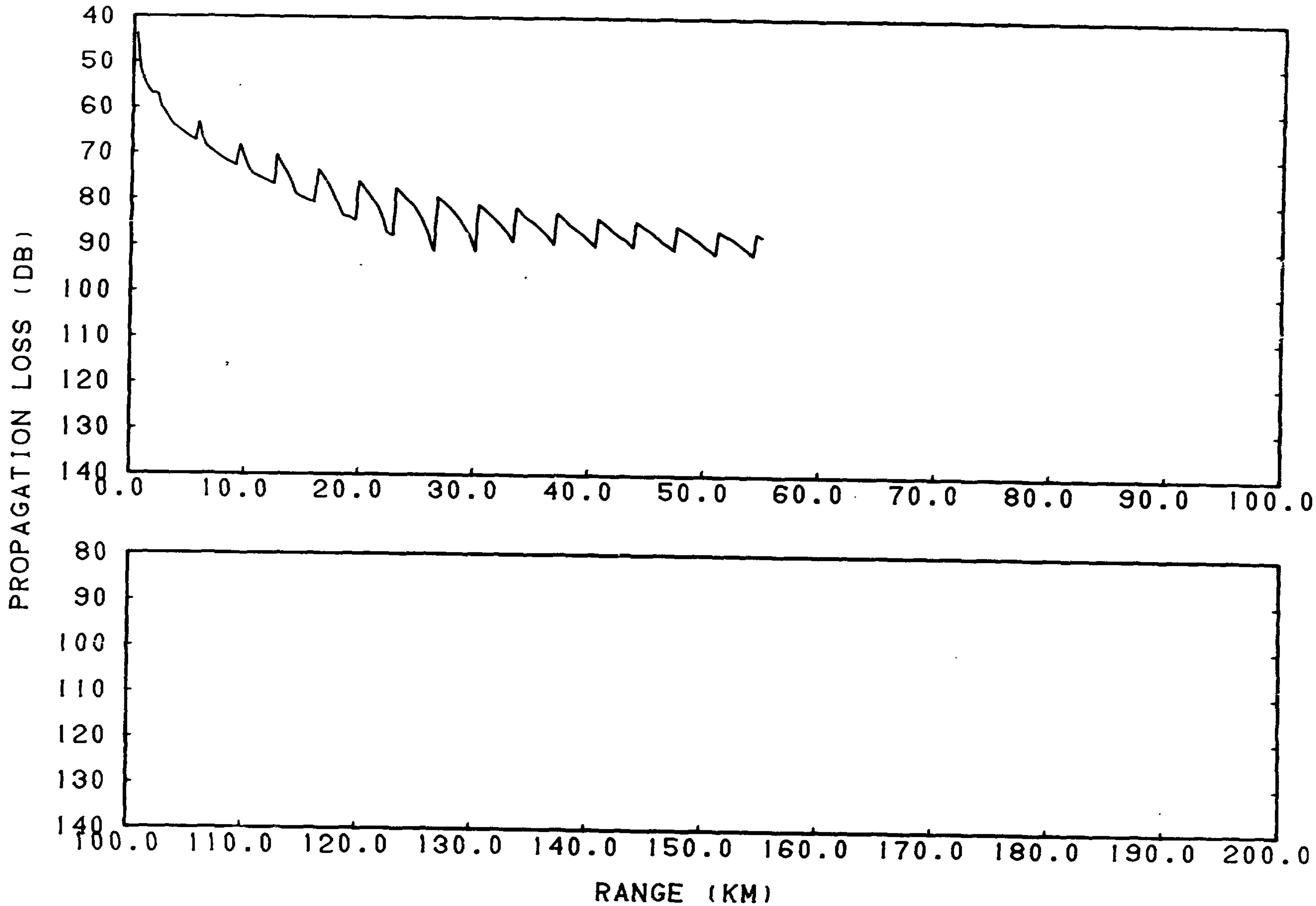
(C) Figure IIG-47. FACT Semi-coherent, Station THORN, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station THORN, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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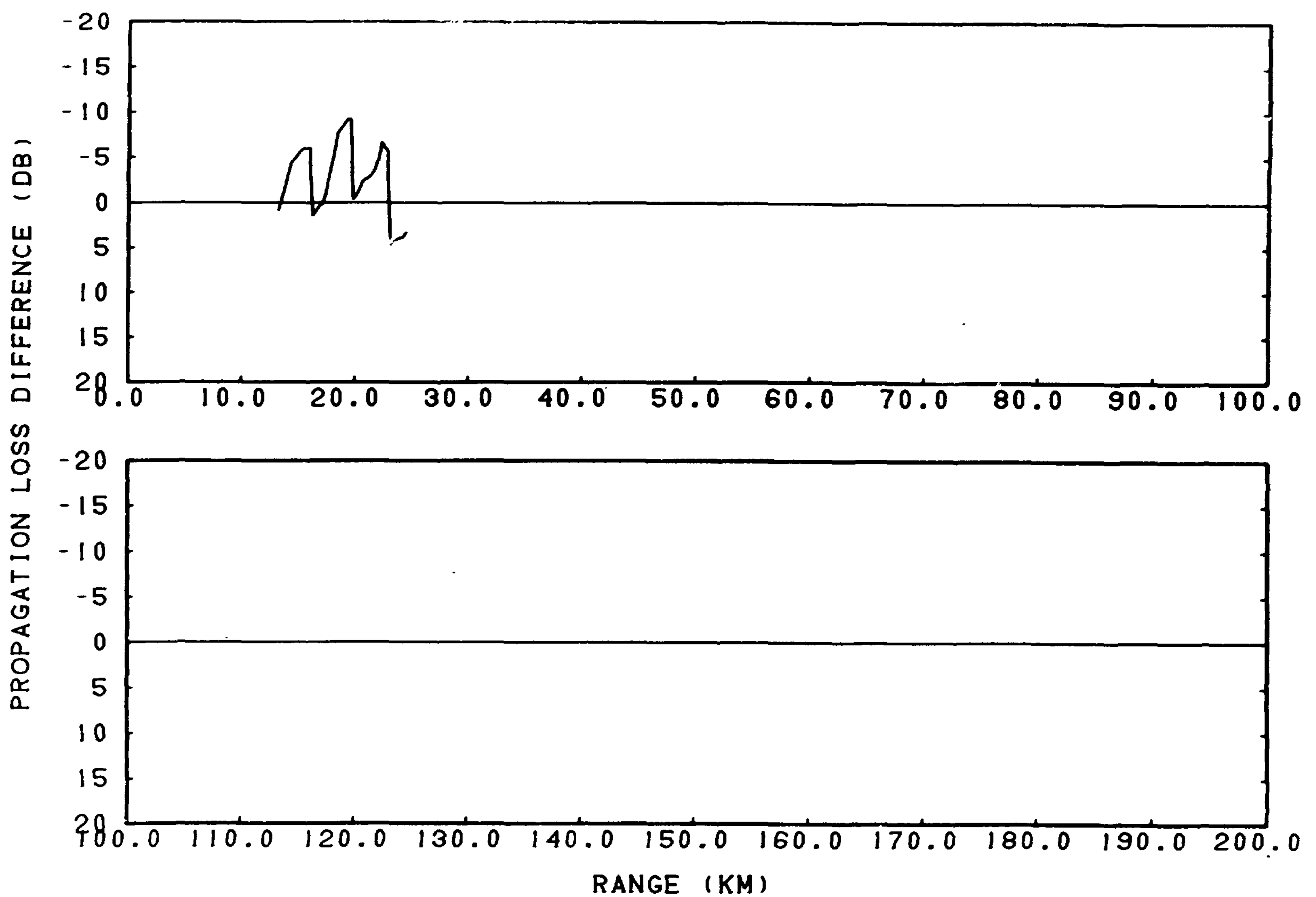
(C) Figure IIG-48. FACT Incoherent, Station THORN, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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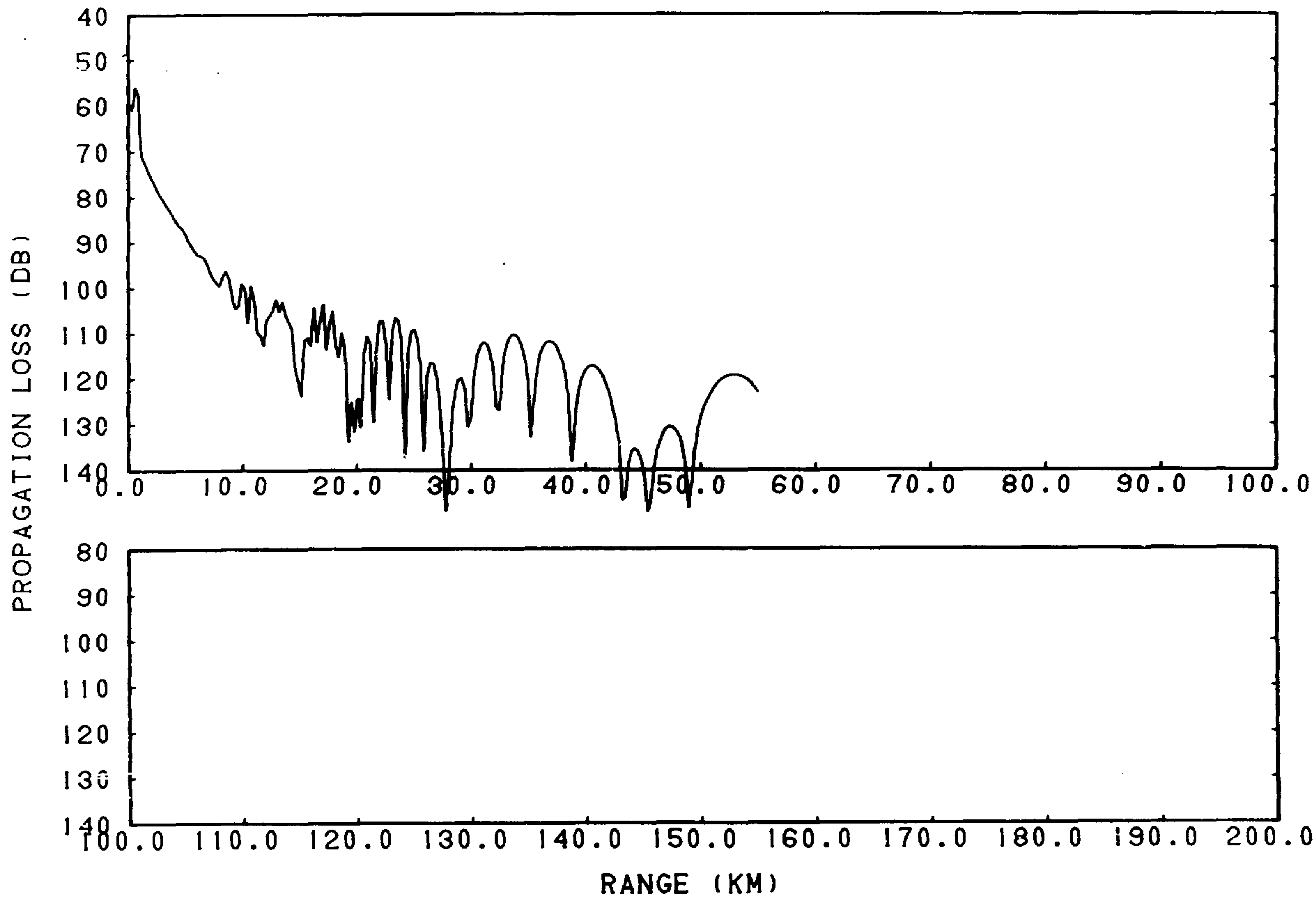
(C) Figure IIG-49. FACT Incoherent, Station THORN, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station THORN, Run 2, Source Depth = 23 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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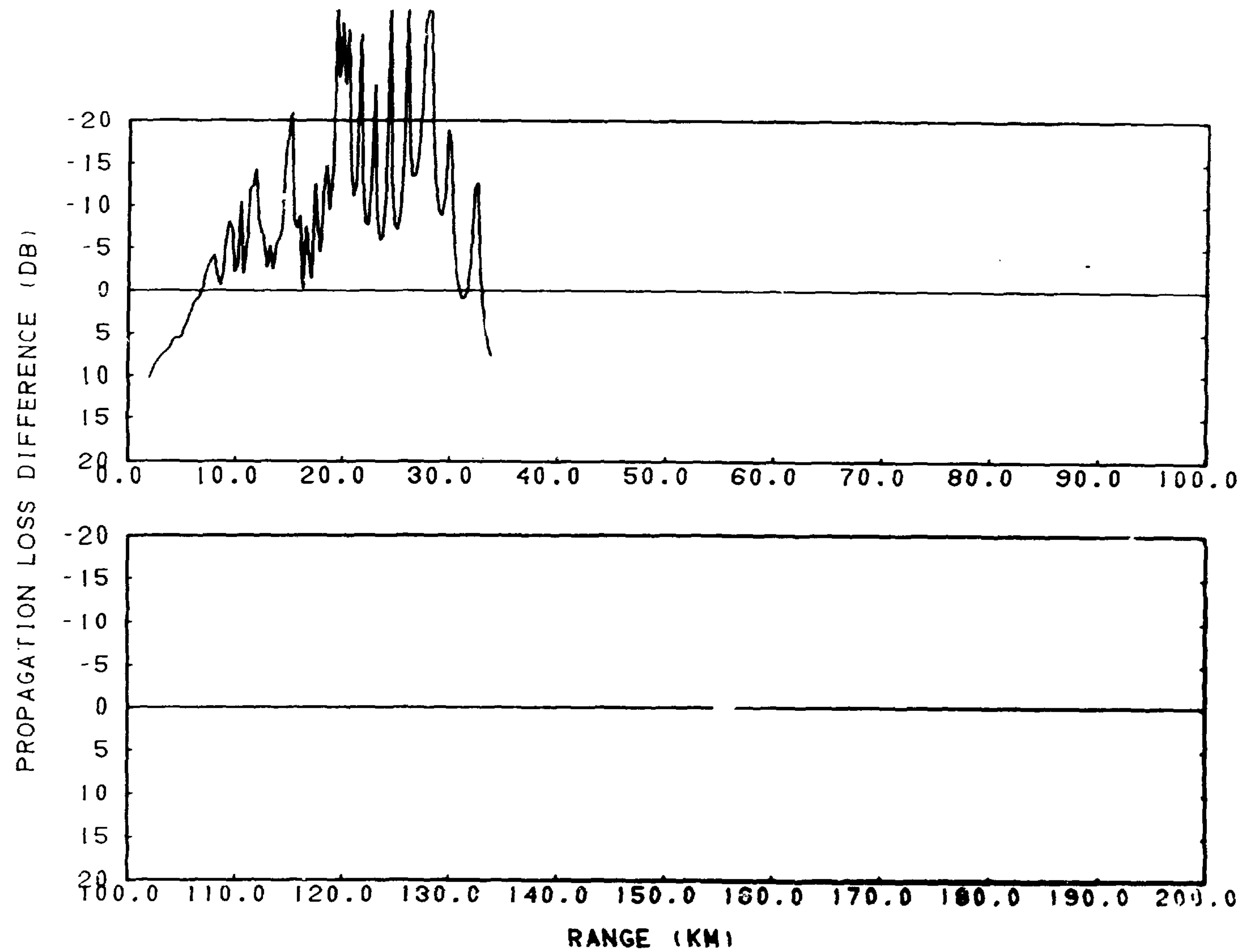
(C) Figure IIG-50. FACT Coherent, Station REDWOOD, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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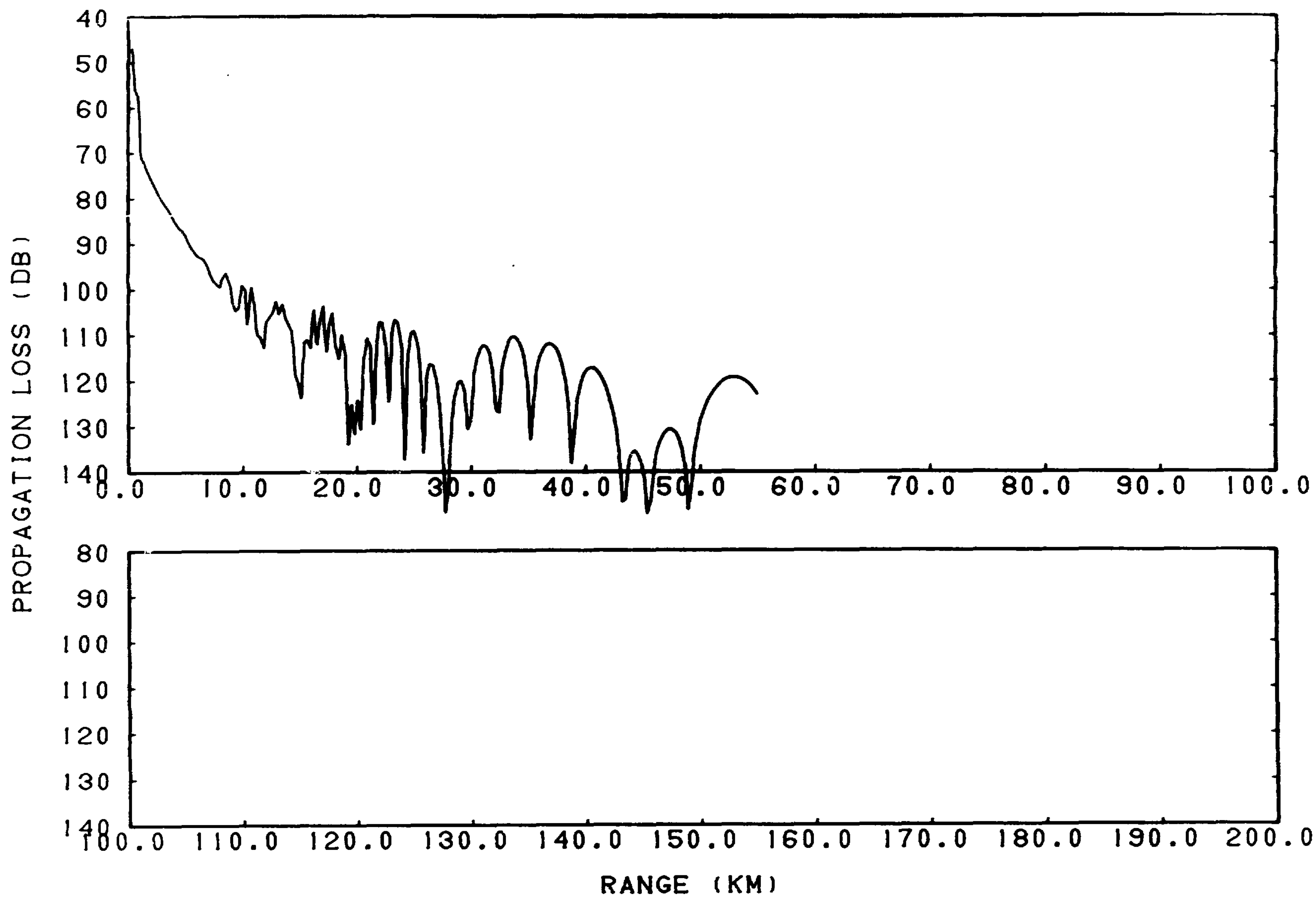
(C) Figure IIG-51. **FACT Coherent, Station REDWOOD, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station REDWOOD, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency - 1500 Hertz**



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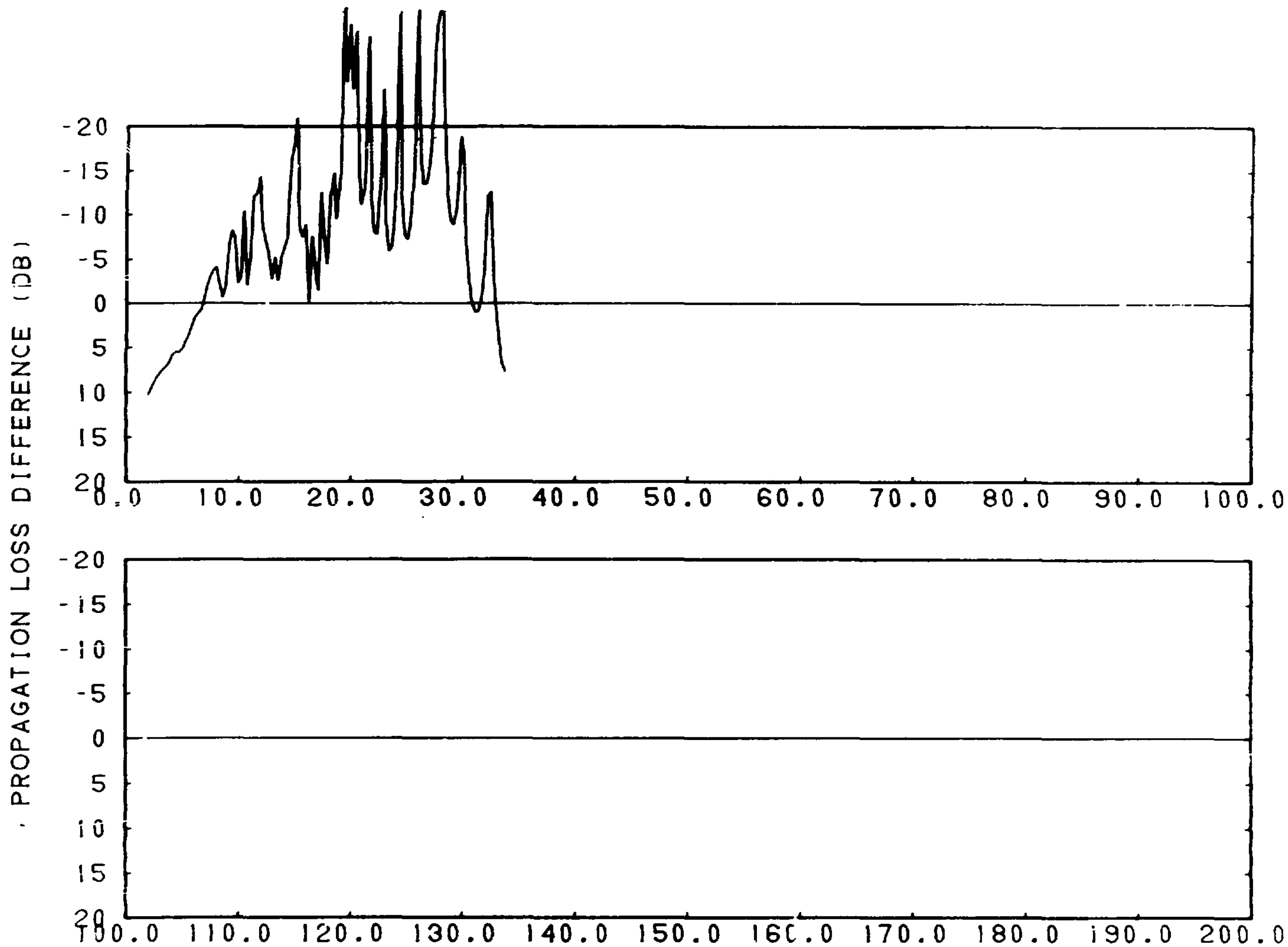
(C) Figure IIG-52. FACT Semi-coherent, Station REDWOOD, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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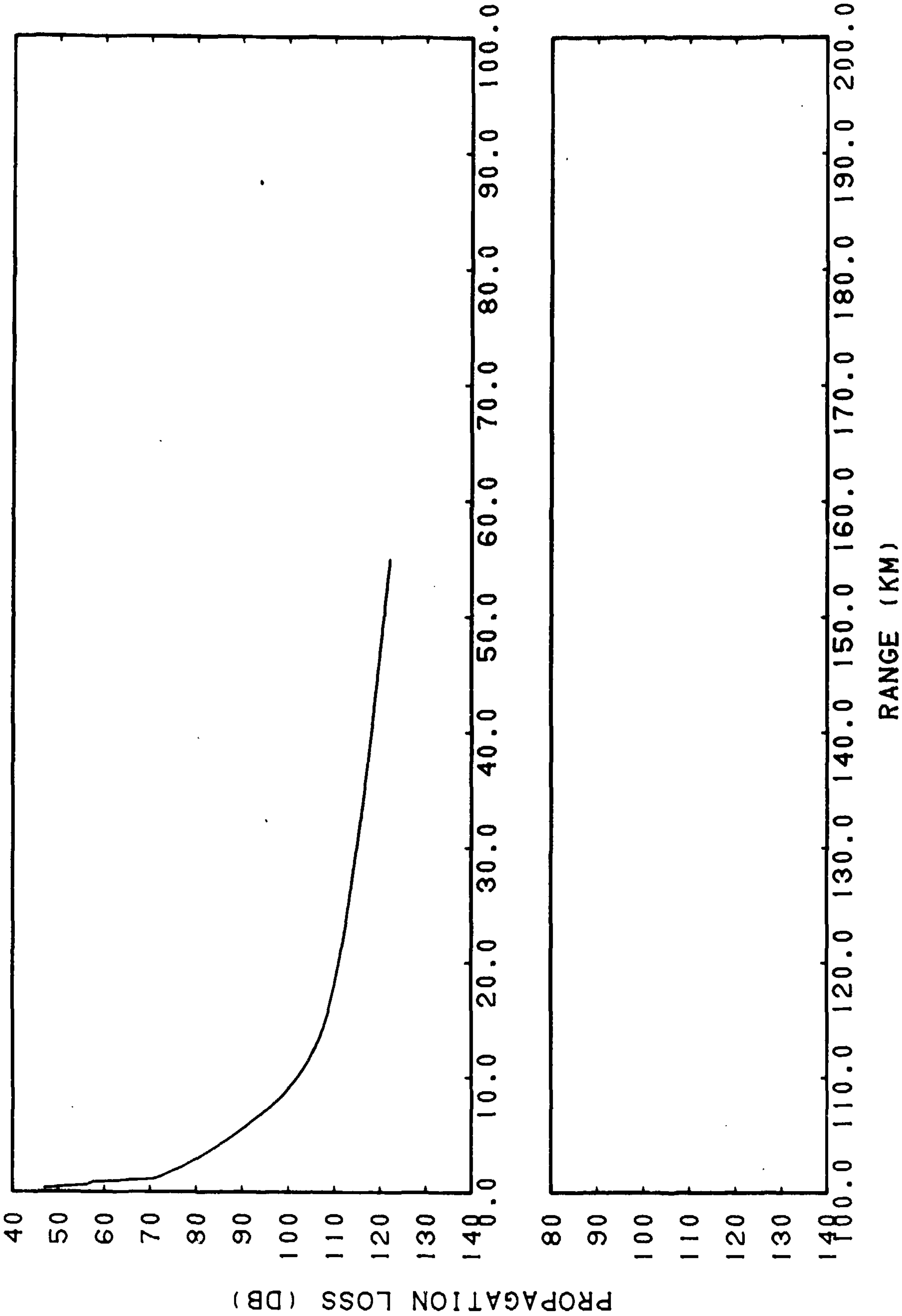
(C) Figure IIG-53. FACT Semi-coherent, Station REDWOOD, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station REDWOOD, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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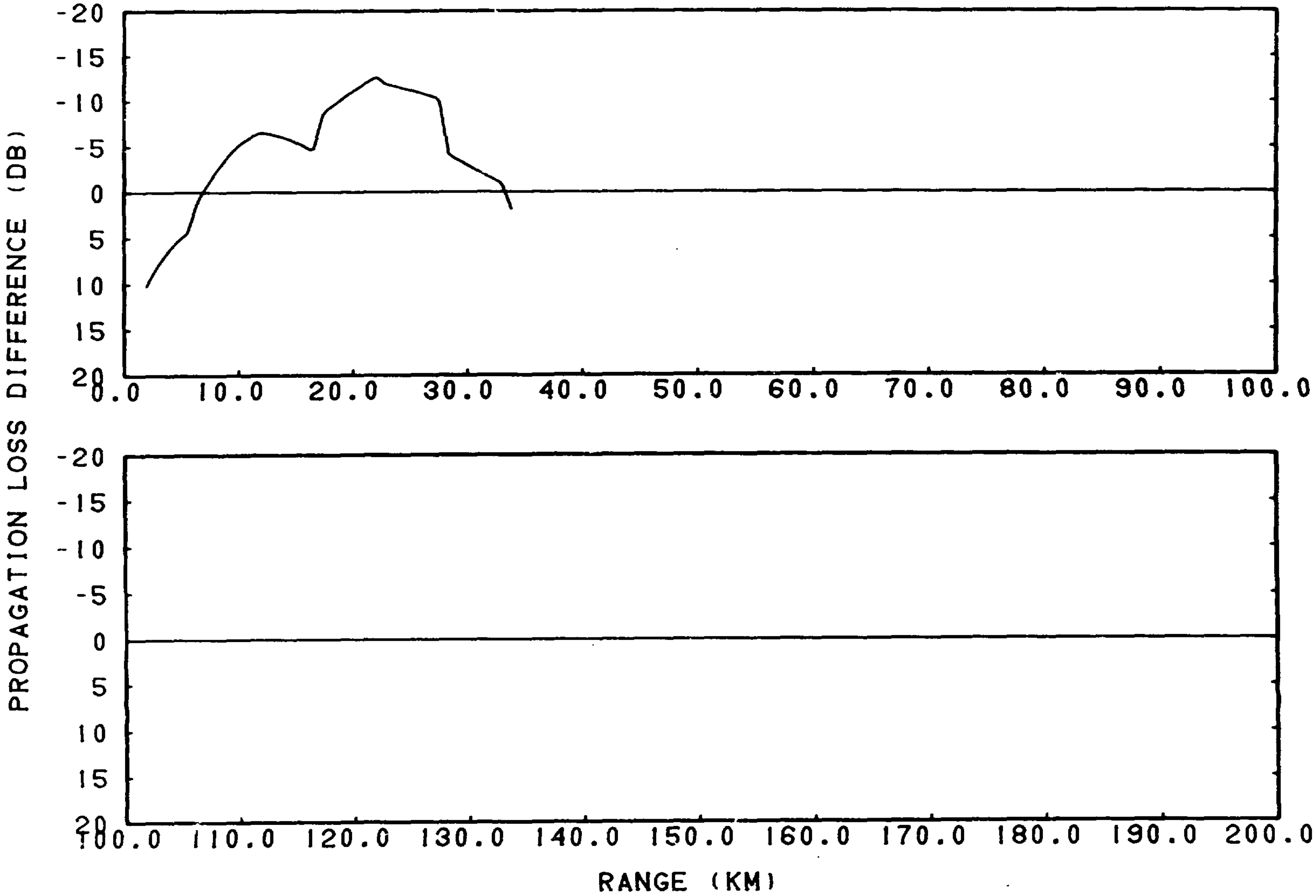
(C) Figure IIG-54. FACT Incoherent, Station REDWOOD, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz



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(C) Figure IIG-55. FACT Incoherent, Station REDWOOD, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz, Subtracted from Smoothed FASOR, Station REDWOOD, Run 3, Source Depth = 6.1 Meters, Receiver Depth = 37 Meters, Frequency = 1500 Hertz

Appendix IIH: Accuracy Assessment of FACT PL9D Compared to GULF OF ALASKA Experimental Data (U)

GULF OF ALASKA (GOA) (U)

Environment (U)

(C) Seven environments in the Gulf of Alaska (GOA) acoustic experiment were chosen as suitable for the evaluation of range independent propagation loss models. The acoustic measurements in the seven environments are referred to as runs 140, 143, 124, 108, 107, 112B, and 112A. The sound speed profiles for these environments are given in Figures IIH-1 through IIH-7. All profiles are basically the same, with shallow sound channels the axes of which vary between 75 and 90 meters. Surface sound speeds are between 1476 and 1480 meters/second. Runs 140, 143, 124, and 112A profiles have a surface duct to a depth of 10 meters. Bottom depths vary from 4042 to 4078 meters. Positive depth excess ranges between 2850 and 3050 meters. The bottom of the sound channel is found between 1000 and 1200 meters (as defined by the reciprocal depth to the surface sound speed or the sound speed at the bottom of the surface duct when one exists).

(C) The bottom loss versus grazing angle curve was the same for all runs and is given in Table IIH-1. This bottom loss curve is for a FNOC Type 6 bottom and is independent of frequency above 1000 hertz. The bottom loss is 9.7 dB at 0 degrees, 17.8 dB at 15 degrees and 18.4 at normal incidence.

Test Cases (U)

(C) There are fourteen test cases for the Gulf of Alaska experiments, correspond responding to two receiver depths for each of seven runs:

CASE	RUN NUMBER	SOURCE DEPTH (m)	RECEIVER DEPTH (m)	FREQUENCY (kHz)	MINIMUM RANGE (km)	MAXIMUM RANGE (km)
I	140	30.5	30.5	1.5	37.0	63.0
II	140	30.5	304.8	1.5	37.0	63.0
III	143	30.5	30.5	1.5	8.5	53.0
IV	143	30.5	304.8	1.5	8.5	53.0
V	124	30.5	30.5	1.5	2.5	11.0
VI	124	30.5	304.8	1.5	2.5	11.0
VII	108	1067.0	30.5	2.5	2.5	28.0
VIII	108	1067.0	304.8	2.5	2.5	28.0
IX	107	1067.0	30.5	2.5	30.0	67.0
X	107	1067.0	304.8	2.5	30.0	67.0
XI	112B	304.8	30.5	2.5	2.0	19.5
XII	112B	304.8	304.8	2.5	2.0	19.5
XIII	112A	304.8	30.5	2.5	15.0	58.0
XIV	112A	304.8	304.8	2.5	15.0	58.0

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(C) In Cases I, III and V, source and receiver are at the same depth in the upper part of the sound channel. In Cases II, IV, and VI, both source and receiver are in the sound channel, but on either side of the axis. In Cases VII through X, the source is below the sound channel and the receiver is in the channel either above the axis at 30.5 m or below the axis at 305 m. For Cases XI through XIV the source is in the lower half of the sound channel and the receiver is either at the same depth of 305 m or above the channel axis at 30.5 m. The dominant propagation is either via the sound channel (purely refracted) paths or half-channel refracted-surface reflected) paths. Due to the nature of the sound speed profile and relatively high bottom loss (FNOC Type 6), bottom reflected energy is not a significant factor.

Accuracy Assessment (U)

(C) The accuracy assessment procedures applied to the FACT PL9D outputs and the experimental data are described in section 1.1 of this volume and in greater detail in section 5 of Volume I of this series with the exception that the coherent model output is not smoothed before subtraction from the experimental data. The Gulf of Alaska experimental data (Cases I-XIV) are plotted in Figures IIH-8 through IIH-21. This same data, after smoothing by a 0.5 kilometer window running average is shown in Figures IIH-22 through IIH-35. The experimental data are characterized by large fluctuations, even after smoothing for Cases I-VI and XIII. It is, therefore, not surprising to see large values of standard deviations of differences for these cases between Gulf of Alaska data and FACT model outputs in Table IIH-2. For each case the following figures are produced: (a) the FACT PL9D coherent output, (b) the FACT coherent result subtracted from Gulf of Alaska data, smoothed in 0.5 kilometer increments, (c) FACT PL9D semicoherent output, (d) FACT PL9D semicoherent output subtracted from Gulf of Alaska data smoothed in 0.5 km increments, (e) FACT PL9D incoherent output, (f) FACT PL9D incoherent output subtracted from Gulf of Alaska data smoothed in 0.5 km increments. These plots are found in Figures IIH-36 through IIH-119 for the fourteen cases.

(C) The means and standard deviations of differences between the smoothed Gulf of Alaska data and the FACT PL9D results (for the three coherence options) are given in Table IIH-2. The smoothing of the GOA data was done in dB space. If instead, the smoothing was in intensity space, these smoothed results would be about 5 dB higher (i.e., less loss) than those done in dB space. This would effectively subtract 5 dB from the means of Table IIH-2 which would improve the result for most cases. For Case I, the FACT output has an anomalous appearance at all ranges. Differences in the three coherence options are not evident beyond about 15 km. The dip in the Gulf of Alaska (GOA) data at 42 km is not seen in the model output and the low loss peak found in the model output at 69 km is not found in the GOA data. These differences, particularly the first, account for both the mean and standard deviation being about 6 dB. In Case II, the high loss feature of the GOA data at 42 km is the greatest cause of disagreement with the model results. Except at very short range (< 3 km) the three FACT coherence options yield the same result. As in Case I, anomalous features are observed in the FACT curve. Here, however, they are attenuated compared to the Case I result. In Case III, the data shows large fluctuations on range scales varying from less than 0.1 km to 10 km. Fluctuations at the rapid end of this spectrum are absent in the FACT model results. Past about 13 km, all FACT phase options yield the same result. Once again, the nature of the FACT fluctuations produces a propagation loss curve which has an anomalous appearance. The FACT low loss peaks at 24 and 47 km are not observed in the GOA data and result in large differences. The rise in the GOA data to a low-loss plateau takes place at 8 km compared to 13 km in the

model results. This contributes to the large standard deviation found (~7 dB). For Case IV, the largest discrepancy is found between 9 and 14 km. In this interval, the GOA data shows oscillation about the 75 dB level while the FACT model predicts a rise from 95 to 85 dB. This region is primarily responsible for the standard deviation of 5.3 dB. Fluctuations for the GOA data are 10-15 dB and are almost nonexistent for the FACT output. For Case V, the FACT output has an anomalous appearance. Although the coherence options gives identical results beyond 13 km, our interest in this case is from 2.5 to 11.0 km. The variability of the model results in this region is reflected in the values of μ and σ. Regardless of phase option, the FACT result shows much greater loss than does GOA data. The level of fluctuations between GOA data and FACT coherent are both in the range of 15 to 20 dB. In Case VI, the three FACT phase options yield identical results between 2.5 and 11.0 km, the interval of the GOA data. The FACT result is a smoothly falling curve in this interval which rides the low-loss peaks of the GOA data. Extreme fluctuations to 6 km in the GOA data are not observed in the model results. In Case VII, the fluctuations of the GOA data and the FACT coherent and semi-coherent results are of similar magnitude. The value of σ for the difference curve would have been smaller had the model results been smoothed as were the GOA data before taking differences. This would not alter the large mean differences between FACT and GOA results (~15 dB) with FACT showing less loss. Also, as reflected in the difference curve, the slope of the FACT propagation loss curve is much greater than that of the GOA results. The incoherent FACT output is smooth in the GOA data region and in strong disagreement with the GOA data. For Case VIII, except for ranges less than 8 km, the three phase options yield the same result which appears to be the result of incoherent phase addition. A large mean difference (~11 dB) is observed between the FACT result and the GOA data. The GOA fluctuations of 10 dB are absent in the FACT prediction. The slope of the FACT result is steeper than that for GOA data. In Case IX, as in Case VII, the coherent and semi-coherent FACT outputs show rapid oscillations with periods of 2 to 3 km. The first convergence zone (CZ) starts at 46 km and ends at 52 km for FACT coherent and semicoherent; for FACT incoherent the CZ extends from 46 to 56 km. The GOA convergence zone starts at 46 km; it is difficult to pinpoint the end of the GOA convergence zone, as it is for the FACT model's CZ. Reasonable agreement is found between the low-loss envelopes of the GOA and FACT coherent and semi-coherent results. Large mean differences (~6 dB) and standard deviations (~7 dB) are largely due to the fact that the GOA data was subjected to a running average and the FACT model results were not. The GOA fluctuations are of the same general magnitude as those for FACT coherent and semicoherent results but are much more rapid (i.e., smaller period). The FACT incoherent results ride at or above the low-loss peaks of the GOA data. When the latter is smoothed a mean difference of ~9 dB is found. In Case X, as in Case VIII, all phase options yield what appears to be an incoherent result except at short ranges (<5 km). A double-lobed convergence zone clearly evident in the FACT result is not double-lobed in the GOA data. Both CZs appear to start at 44 km; the FACT CZ ends at 48 km compared to the GOA CZ end at 51 km. The FACT curve closely corresponds to the GOA low-loss envelope. It is clear that the FACT result shows no fluctuations; GOA data fluctuations are about 10 dB with periods of 0.1 km or less. In Case XI, the FACT interference structure has an anomalous character. For ranges greater than 3 km, the three coherence options yield the same result. The GOA data shows an interference structure which is absent in the model result. With the exception of one small (anomalous in FACT) interval, the model shows less loss than the GOA data. The slopes of the GOA and FACT curves are quite similar. GOA data show 3-5 dB rapid fluctuations; FACT has none. In Case

XII, the envelope of the GOA data and the FACT curve have nearly identical shapes, which accounts for the small standard deviation (of the difference between smoothed GOA data and the FACT curve). Rapid GOA fluctuations between 5 and 10 dB are not evident in FACT results, which have an anomalous interference pattern and are identical for all phase options. In Case XIII, the FACT result is again independent of phase option chosen and has what appears to be an anomalous interference pattern. The interference structure seen in the GOA data between 15 and 22 km is well modeled by FACT although the FACT result is at lower loss (i.e., roughly parallel to the GOA result in this interval). The GOA fluctuations are rapid and between 10 and 15 dB (longer period interference patterns of approximately 1 to 2 km exhibit 3 to 5 dB rapid fluctuations modulating the longer patterns. The FACT curve rides on or above the GOA low-loss envelope. For Case XIV, the FACT interference structure again has an anomalous appearance. The three coherence options yield the same result. The FACT curve once again shows losses less than or equal to those of the GOA low-loss envelope. Fine scale fluctuations of 5 to 10 dB are seen in GOA data; none are evident in FACT.

(C) We now turn to the Figure of Merit (FOM) results. Tables IIH-3 through IIH-16 give detection coverage as a function of figure of merit in 5 dB steps for the fourteen cases. In what follows we shall refer to detections per opportunity ratio. This is the same as Zonal Detection Coverage (ZDC) as listed and defined in the tables. For Case I, at FOM = 80 dB, coverage is slight and comparable for GOA and FACT. At FOM = 85 dB, FACT coverage has a large gap but is complete otherwise; GOA's coverage shows a smaller gap but the chances of detection on a single ping basis are less than FACT's in areas of mutual coverage. The results for FOM = 90 dB are similar to those for 85 dB; At FOM = 95 dB, both FACT and GOA show detection coverage over the entire interval. FACT has a detections per opportunity ratio of 1.0 at all ranges; GOA has ratios varying between 0.2 and 0.95 depending on range. At FOM = 100 dB, the GOA ratios are between 0.5 and 0.95 and at FOM = 105 dB the GOA ratios vary between 0.8 and 0.98 (the FACT PL9D detection opportunity ratio is 1.0 for these FOMs). For Case II, GOA coverage is much more extensive than is FACT. At FOM = 85 dB, GOAs coverage is complete but only slightly greater than FACT's; FACT's coverage, however, is complete whereas GOA's coverage varies from 10% to 60% (i.e., percentage of detections per opportunity). For FOM ≥ 90 dB, both GOA and FACT have detection coverage over the entire range interval although FACT has an advantage in Zonal Detection Coverage precentage. For Case III, at FOM = 75 dB, GOA and FACT have roughly equivalent coverage. At FOM = 80 dB, the GOA coverage is much more extensive than FACT's. At FOM = 85 dB, GOA coverage is more extensive than FACT's, but FACT's is at 100% detections per opportunity whereas GOA's varies between 20 and 50%. For FOM ≥ 90, GOA and FACT have essentially complete coverage over the GOA data interval; however, FACT is at the 100% detection per opportunity level and GOA's percentage is variable and depends on range. For Case IV, at FOM = 75 dB FACT shows no coverage. GOA has coverage over a 15 kilometer interval but at a 10% detections per opportunity ratio. At 80 and 85 dB, GOA's coverage is broader, but FACT's is at the 100% level. At FOM ≥ 90 dB, both GOA and FACT have essentially complete coverage over the GOA data interval. FACT's coverage is at the 100% level which is approached by GOA data for FOM ≥ 95 dB. In Case V, GOA data shows much greater coverage than FACT results for FOM ≤ 90 dB. At FOM = 95 dB, coverage is over the entire GOA data interval (2.5-11 km) but at a much higher detections per opportunity percentage for GOA than for FACT. For FOM ≥ 100 dB, GOA and FACT give complete range coverage at a percentage of 90 or better. For Case VI, FACT and GOA show detection coverage over the range interval (2.5-11 km) regardless of FOM. The FACT Zonal

Detection Coverage (ZDC) percentage is 100% at all FOMs; the GOA ZDC increases from 50% to 95% as FOM increases from 75 to 100 dB. For Case VII, GOA shows essentially no detection coverage at FOM $\leq$ 85 dB while FACT shows substantial coverage. At FOM $\geq$ 95 dB, GOA and FACT show coverage over the entire interval (2.5-28 km) but at a higher detection per opportunity percentage for FACT. For Case VIII, FACT again has better detection coverage than GOA data. At FOM = 75 dB, GOA coverage is a point; FACT's is 3 km. At FOM = 80 and 85 dB, FACT's coverage is far more extensive than GOA's. For FOM $\geq$ 90 dB, FACT's coverage is total over the range interval (2.5-28 km); GOA has coverage over the entire range interval but at varying detection per opportunity percentages. For Case IX, neither GOA nor FACT show coverage, aside from convergence zone, for FOM = 85 dB. GOA has no coverage in the range interval (30-67 km) at FOM = 90 dB, but FACT shows slight coverage at the start of this interval. At 95 dB, GOA still has no coverage and FACT's now extends to 42 km. For FOM $\geq$ 100 dB, GOA and FACT have coverage over the range interval; FACT's is at the 100% detections per opportunity level for incoherent phase while GOA's is variable. CZ start ranges are identical for GOA and FACT. The CZ end range results are variable and depend on FOM. At FOM = 85 dB, FACT shows a CZ; GOA does not. For Case X, GOA and FACT show nearly identical CZ start and end ranges at FOM = 90 dB. At FOM $\geq$ 95 dB, FACT has 100% detection coverage over the GOA data interval of 30-67 km. GOA shows coverage at all ranges but at varying detection per opportunity percentages. In Case XI, GOA and FACT has very similar detection coverage in terms of range interval. FACT, however, has a higher (actually 100%) detections per oportunity percentage than GOA data. In Case XII, FACT has broader detection range coverage and/or higher detection per opportunity percentage. With the exception of FOM = 90 dB, this is also true for CASE XIII. For Case XIV, at FOM = 80 dB, GOA percentage level is low but coverage is continuous over an 18 km interval; this compares with spotty coverage at the 100% level for FACT - the sum of FACT's range coverage is 12 km. The same general situation is found for FOM = 85 dB. At FOM $\geq$ 90 dB, GOA and FACT have detection capability over the 15-58 km GOA data range interval. FACT has 100% detection per opportunity percentage whereas GOA's varies with range and FOM.

(C) General Conclusions: (1) For the arctic sound speed field, FACT results were insensitive to phase option chosen over most of the range interval when the receiver was deep (305 meters). (2) In many cases, the FACT interference structure had an anomalous appearance. (3) In most cases at 2.5 kHz, FACT showed less loss than GOA data to the extent that the FACT curve often provided a low-loss envelope for the GOA data. (4) In all cases FACT showed no fluctuations at periods of less than 1 km except between 5 and 15 km; the GOA data typically showed fluctuations of 10 dB at periods less than 1 km. (5) FACT and GOA results at 1.5 kHz showed no basic agreement in shape of the propagation loss curve or features therein. (6) The large negative differences in Case V would appear to arise from an inconsistency in the FACT results rather than in the GOA data. (7) At 1.5 kHz, the Gulf of Alaska data shows better coverage than FACT in terms of percentage of the possible range interval covered at a given FOM. When both cover a given range segment, however, FACT usually has a 100% detection per opportunity ratio while GOA's percentage is both range and FOM dependent. (8) At 2.5 kHz, the Gulf of Alaska data shows poorer or equal coverage to FACT in terms of percentage of the possible range interval covered at a given FOM. When both cover a given range segment, FACT usually has a 100% detection per opportunity ratio while GOA's percentage is both range and FOM dependent.

(C) Table IIH-1. Bottom Loss in dB versus Grazing Angle in degrees. FNOC Type 6. Frequency ≥1000 Hertz.

Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL	Θ	BL
0	9.7	15	17.8	30	19.4	45	18.7	60	18.5	75	18.9
1	10.6	16	18.1	31	19.3	46	18.7	61	18.5	76	18.9
2	11.4	17	18.3	32	19.3	47	18.7	62	18.5	77	18.9
3	12.1	18	18.5	33	19.3	48	18.6	63	18.5	78	19.0
4	12.8	19	18.7	34	19.3	49	18.6	64	18.5	79	19.0
5	13.5	20	18.8	35	19.2	50	18.5	65	18.6	80	19.0
6	14.1	21	18.9	36	19.2	51	18.5	66	18.6	81	19.0
7	14.7	22	19.0	37	19.1	52	18.5	67	18.6	82	18.9
8	15.2	23	19.1	38	19.1	53	18.5	68	18.7	83	18.9
9	15.7	24	19.2	39	19.0	54	18.5	69	18.7	84	18.9
10	16.1	25	19.3	40	19.0	55	18.4	70	18.7	85	18.8
11	16.4	26	19.3	41	18.9	56	18.4	71	18.8	86	18.8
12	16.9	27	19.3	42	18.9	57	18.4	72	18.8	87	18.7
13	17.3	28	19.4	43	18.8	58	18.4	73	18.8	88	18.6
14	17.6	29	19.4	44	18.8	59	18.5	74	18.9	89	18.5

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(U) Table IIH-2. Means (μ) and Standard Deviations (σ) in dB of Differences Obtained by Subtracting FACT PL9D Model Results from Gulf of Alaska Experimental Data.[1]

					FACT Coherent[1]		FACT Semicoherent		FACT Incoherent	
Case	Run	Freq. (kHz)	Source Depth (m)	Receiver Depth (m)	μ	σ	μ	σ	μ	σ
I	140	1.5	30.5	30.5	6.2	6.0	6.2	6.0	6.2	6.0
II	140	1.5	30.5	304.8	3.2	4.3	3.2	4.3	3.2	4.3
III	143	1.5	30.5	30.5	2.4	7.6	2.7	6.6	2.7	6.5
IV	143	1.5	30.5	304.8	-0.3	5.3	-0.3	5.3	-0.3	5.3
V	124	1.5	30.5	30.5	-15.6	10.2	-10.1	3.1	-10.3	3.4
VI	124	1.5	30.5	304.8	6.7	3.8	6.7	3.8	6.7	3.8
VII	108	2.5	1067	30.5	14.1	6.8	14.2	6.8	16.0	4.1
VIII	108	2.5	1067	304.8	11.0	2.7	11.0	2.7	11.0	2.7
IX	107	2.5	1067	30.5	6.3	7.0	6.3	6.9	3.9	2.2
X	107	2.5	1067	304.8	5.9	2.0	5.9	2.0	5.9	2.0
XI	112B	2.5	304.8	30.5	8.7	4.2	8.7	4.2	8.7	4.2
XII	112B	2.5	304.8	304.8	8.6	2.8	8.6	2.8	8.6	2.8
XIII	112A	2.5	304.8	30.5	9.1	4.3	9.2	4.3	9.2	4.3
XIV	112A	2.5	304.8	304.8	7.7	3.4	7.7	3.4	7.7	3.4

1. Gulf of Alaska data were smoothed by application of a running average with a 2 kilometer window.

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(C) Table IIH-3. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 140 (37-63 km) Experimental Data and FACT PL9D Model Results.
CASE I:
(Source Depth = 30.5 m, Receiver Depth = 30.5 m, Frequency = 1.5 kHz))
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c[1]	Range > R_c
Gulf of Alaska	80		ZDC[2] 50%, 38-40 km
FACT PL9D[3]	80		100% coverage, 38.5-42.5 & 57.5-59.5 km
Gulf of Alaska	85		ZDC 30%, 37-41 km; ZDC 15%, 44.5-61 km
FACT PL9D[3]	85		100% coverage 37-44.5, 57.5-63 km
Gulf of Alaska	90		ZDC 80%, 37-41 km; ZDC 50%, 43-63 km
FACT PL9D[3]	90		100% coverage, 37-52.5 & 57.5-63 km
Gulf of Alaska	95		ZDC 95%, 37-40 km; ZDC 20%, 40-50 km; ZDC 85%, 50-63 km
FACT PL9D[3]	95		100% coverage, 37-63 km
Gulf of Alaska	100	40.5	ZDC 50%, 40.5-50 km; ZDC 95%, 50-63 km
FACT PL9D[3]	100		100% coverage, 37-63 km
Gulf of Alaska	105	42.0	ZDC 80%, 42-43.5 km; 98%, coverage past 43.5 km
FACT PL9D[3]	105		100% coverage, 37-63 km

1. R_c = Range to which detection coverage is continuous.
2. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.
3. FACT PL9D coherent, semicoherent, and incoherent outputs give identical detection coverage at this FOM (over the Gulf of Alaska data interval: 37-63 km).

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(C) Table IIH-4. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 140 (37-63 km) Experimental Data and FACT PL9D Model Results.
CASE II:
(Source Depth = 30.5 m, Receiver Depth = 305 m, Frequency = 1.5 kHz)
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c [1]	Range > R_c
Gulf of Alaska	75		100% coverage, 47-48 km
FACT PL9D[2]	75		
Gulf of Alaska	80		100% coverage, 38-40 km; ZDC[3] 20%, 46-54.5 km
FACT PL9D[2]	80		100% coverage, 37-39.5 km
Gulf of Alaska	85		ZDC 60%, 37-40 km; ZDC 10%, 40-45 km; ZDC 50%, 45-63 km
FACT PL9D[2]	85		100% coverage 37-47, 49.5-56
Gulf of Alaska	90		ZDC 95%, 37-40 km; ZDC 20%, 40-44 km; ZDC 70%, 44-63 km
FACT PL9D[2]	90		100% coverage, 37-63 km
Gulf of Alaska	95		100% coverage, 37-40 km; ZDC 60%, 40-44 km; 100% coverage, 44-52.5 km; ZDC 85%, 52.5-63 km
FACT PL9D[2]	95		100% coverage, 37-63 km
Gulf of Alaska	100		100% coverage, 37-40 km; ZDC 85%, 40-44 km; ZDC 95%, 44-63 km
FACT PL9D[2]	100		100% coverage, 37-63 km

1. R_c = Range to which detection coverage is continuous.

2. FACT PL9D coherent, semicoherent, and incoherent outputs are identical over the Gulf of Alaska data interval (37-63 km).

3. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.

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(C) Table IIH-5. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 143 (8.5-53.0 km) Experimental Data and FACT PL9D Model Results.
CASE III:
(Source Depth = 30.5 m, Receiver Depth = 30.5 m, Frequency = 1.5 kHz)
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c[1]	Range R_c
Gulf of Alaska	75		ZDC[2] 65%, 19-21.5 km
FACT[3]	75		100% coverage, 22.5-24.5 km
Gulf of Alaska	80		ZDC 25%, 10.5-30 km
FACT[3]	80		100% coverage, 13.5-14 km, 22-26 km & 45-48.5 km
Gulf of Alaska	85		ZDC 50%, 10-38 km; ZDC 20%, 41.5-52 km
FACT[3]	85		100% coverage, 13-16.5 km, 20-32 km, 38.5-39 km & 44.5-50 km
Gulf of Alaska	90		ZDC 30%, 10-13 km; ZDC 80%, 13-30.5 km; ZDC 40%, 30.5-53 km
FACT[3]	90		100% coverage, 13.5-53 km
Gulf of Alaska	95		ZDC 40%, 9-13 km; ZDC 90%, 13-30.5 km; ZDC 60%, 30.5-53 km
FACT Coherent	95		ZDC 20%, 8.5-13 km; 100% coverage past 13 km
FACT Semicoherent	95		100% coverage past 13 km
FACT Incoherent	95	8.5	100% coverage past 13 km
Gulf of Alaska	100		ZDC 70%, 9-13 km; ZDC 90%, 9-38 km; ZDC 80%, 38-53 km
FACT Coherent	100		ZDC 50%, 8.5-13 km; 100% coverage past 13 km
FACT Semicoherent	100	11.5	ZDC 80%, 11.5-13 km; 100% coverage past 13 km
FACT Incoherent	100	>53	
Gulf of Alaska	105		ZDC 80%, 8.5-12.5 km; ZDC 98%, 12.5-38 km; ZDC 85%, 38-41 km; 100% coverage, 41-53 km
FACT Coherent	105	10	ZDC 80%, 10-13 km; 100% coverage past 13 km
FACT Semicoherent	105	>53	
FACT Incoherent	105	>53	
Gulf of Alaska	110		ZDC 90%, 8.5-12.5 km; 100% coverage 12.5-53 km
FACT Coherent	110	11.5	ZDC 80%, 11.5-13 km; 100% coverage past 13 km
FACT Semicoherent	110	>53	
FACT Incoherent	110	>53	

1. R_c = Range to which detection coverage is continuous.
2. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.
3. FACT PL9D coherent, semicoherent, and incoherent outputs give identical detection coverage at this FOM.

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(C) Table IIH-6. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 143 (8.5-53.0 km) Experimental Data and FACT PL9D Model Results.
CASE IV:
(Source Depth = 30.5 m, Receiver Depth = 305 m, Frequency = 1.5 kHz)
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c[1]	Range > R_c
Gulf of Alaska	75		ZDC[2] 10%, 9.5-24.5 km
FACT[3]	75		
Gulf of Alaska	80		ZDC 40%, 9.5-35 km; ZDC 15%, 35-53 km
FACT[3]	80		100% coverage, 16-21 km and 23-28 km
Gulf of Alaska	85		ZDC 90%, 9-29.5 km; ZDC 40%, 29.5-53 km
FACT[3]	85		100% coverage, 13.5-21, 22-32, 38.5-45.5, 47.5-53 km
Gulf of Alaska	90		ZDC 90%, 8.5-30 km; ZDC 60%, 30-53 km
FACT[3]	90		100% coverage 11-53 km
Gulf of Alaska	95		ZDC 98%, 8.5-30 km; ZDC 95%, 30-53 km
FACT Coherent	95		ZDC 50%, 8.5-10 km; 100% coverage past 10 km
FACT Semi & Incoherent	95	>53	
Gulf of Alaska	100		ZDC 95%, 8.5-53 km
FACT[3]	100	>53	

1. R_c = Range to which detection coverage is continuous.

2. ZDC = Zonal Detection Coverage in percentage of indicated range interval over which detection is possible.

3. FACT PL9D coherent, semicoherent and incoherent outputs give identical detection coverage at this FOM.

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(C) Table IIH-7. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 124 (2.5-11.0 km) Experimental Data and FACT PL9D Model Results.
CASE V:
(Source Depth = 30.5 m, Receiver Depth = 30.5 m, Frequency = 1.5 kHz)
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c[1]	Range > R_c
Gulf of Alaska	75		ZDC[2] 65%, 4-6 km
FACT Coherent	75		
FACT Semicoherent	75		
FACT Incoherent	75		
Gulf of Alaska	80		ZDC 60%, 3.5-11 km
FACT Coherent	80		
FACT Semicoherent	80		
FACT Incoherent	80		
Gulf of Alaska	85		ZDC 70%, 3.5-11 km
FACT Coherent	85	2.5	
FACT Semicoherent	85	2.5	
FACT Incoherent	85	2.5	
Gulf of Alaska	90		ZDC 80%, 2.5-11 km
FACT Coherent	90	3.5	
FACT Semicoherent	90	3.0	
FACT Incoherent	90	3.0	
Gulf of Alaska	95		ZDC 85%, 2.5-11 km
FACT Coherent	95	3.5	ZDC 25%, 3.5-11 km
FACT Semicoherent	95	5.5	ZDC 30%, 5.5-11 km
FACT Incoherent	95	8.0	
Gulf of Alaska	100		ZDC 90%, 2.5-11 km
FACT Coherent	100	3.5	ZDC 60%, 3.5-11 km
FACT Semicoherent	100	>11	
FACT Incoherent	100	>11	
Gulf of Alaska	105		ZDC 95%, 2.5-11 km
FACT Coherent	105	4.5	ZDC 80%, 3.5-11 km
FACT Semicoherent	105	>11	
FACT Incoherent	105	>11	
Gulf of Alaska	110		ZDC 85%, 2.5-11 km
FACT Coherent	110	4.5	ZDC 60%, 4.5-8.5 km; 100% coverage past 8.5 km
FACT Semicoherent	110	>11	
FACT Incoherent	110	>11	

1. R_c = Range to which detection coverage is continuous.
2. ZDC = Zonal Detection Coverage in percentage of the indicated range over which detection is possible.

(C) Table IIH-8. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 124 (2.5-11 km) Experimental Data and FACT PL9D Model Results.
CASE VI:
(Source Depth = 30.5 m, Receiver Depth = 305 m, Frequency = 1.5 kHz)
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c [1]	Range > R_c
Gulf of Alaska	75		ZDC[2] 50%, 2.5-11 km
FACT PL9D[3]	75	10	
Gulf of Alaska	80		ZDC 75%, 2.5-11 km
FACT PL9D	80	>11	
Gulf of Alaska	85		ZDC 60%, 2.5-6 km; 100% coverage past 6 km
FACT PL9D	85	>11	
Gulf of Alaska	90		ZDC 70%, 2.5-6 km; 100% coverage past 6 km
FACT PL9D	90	>11	
Gulf of Alaska	95		ZDC 85%, 2.5-6 km; 100% coverage past 6 km
FACT PL9D	95	>11	
Gulf of Alaska	100		ZDC 95%, 2.5-6 km; 100% coverage past 6 km
FACT PL9D	100	>11	

1. R_c = Range to which detection coverage is continuous.
2. ZDC = Zonal Detection Coverage in percentage of the indicated range over which detection is possible.
3. FACT PL9D results for coherent, semicoherent and incoherent phase options are identical over the Gulf of Alaska data interval (2.5-11.0 km).

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(C) Table IIH-9. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 108 (2.5-28.0 km) Experimental Data and FACT PL9D Model Results.
CASE VII:
(Source Depth = 1067 m, Receiver Depth = 30.5 m, Frequency = 2.5 kHz)
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c [1]	Range > R_c
Gulf of Alaska	75		
FACT Coherent and Semicoherent	75		ZDC[2] 90%, 2.5-6.5 km
FACT Incoherent	75	7.0	
Gulf of Alaska	80		Single peak at 2.5 km
FACT Coherent and Semicoherent	80		ZDC 90%, 2.5-14.5 km; 100% coverage, 18-19 km
FACT Incoherent	80	15.0	
Gulf of Alaska	85		Single peaks at 2.5 and 8.5 km
FACT Coherent and Semicoherent	85	10.0	ZDC 70%, 10-24 km
FACT Incoherent	85	24.0	
Gulf of Alaska	90		ZDC 20%, 2.5-20 km; 100% coverage 27.5-28 km
FACT Coherent and Semicoherent	90	20.0	ZDC 60%, 20-28 km
FACT Incoherent	90	>28.0	
Gulf of Alaska	95		ZDC 40%, 2.5-28 km
FACT Coherent and Semicoherent	95	20.0	ZDC 90%, 20-28 km
FACT Incoherent	95	>28.0	
Gulf of Alaska	100		ZDC 60%, 2.5-28 km
FACT Coherent and Semicoherent	100		100% coverage, 2.5-28 km with exception of spike at 20 km
FACT	100	>28.0	
Gulf of Alaska	105		ZDC 80%, 2.5-20 km
FACT Coherent and Semicoherent	105	>28.0	
FACT Incoherent	105	>28.0	
Gulf of Alaska	110		ZDC 95%, 2.5-28 km
FACT Coherent and Semicoherent	110	>28.0	
FACT Incoherent	110	>28.0	

1. R_c = Range to which detection coverage is continuous.
2. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.

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(C) Table IIH-10. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 108 (2.5-28.0 km) Experimental Data and FACT PL9D Model Results.
CASE VIII:
(Source Depth = 1067 m, Receiver Depth = 305 m, Frequency = 2.5 kHz)
Bottom Loss: FNOC Type 6.

DATA SET	FOM	R_c [1]	Range > R_c
Gulf of Alaska	75		Single peak at 2.5 km
FACT PL9D[2]	75		ZDC[3] 80%, 2.5-5.5 km
Gulf of Alaska	80		100% coverage, 2.5-3.5 km
FACT PL9D[2]	80	13.5	
Gulf of Alaska	85		ZDC 10%, 2.5-20 km; single peak at 25 km
FACT PL9D[2]	85	24.0	
Gulf of Alaska	90		ZDC 70%, 2.5-9 km; ZDC 50%, 9-20.5, ZDC 15%, 23-28 km
FACT PL9D[2]	90	>28.0	
Gulf of Alaska	95		ZDC 95%, 2.5-9 km; ZDC 75%, 9-20 km; ZDC 60%, 20-28 km
FACT PL9D[2]	95	>28.0	
Gulf of Alaska	100		ZDC 98%, 2.5-20 km; ZDC 90%, 20-28 km
FACT PL9D[2]	100	>28.0	

1. R_c = Range to which detection coverage is continuous.
2. FACT PL9D coherent, semicoherent and incoherent outputs are identical over the Gulf of Alaska data interval (2.5-28.0 km).
3. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.

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(C) Table IIH-11. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 107 (30-67 km) Experimental Data and FACT PL9D Model Results.
CASE IX:
(Source Depth = 1067 m, Receiver Depth = 30.5 m, Frequency = 2.5 kHz)
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c[1]	CZ Start	CZ End	
Gulf of Alaska	85				
FACT Coherent and Semicoherent	85		45.5	46.5	
FACT Incoherent	85		45.5	46.5	
Gulf of Alaska	90		45.0	48.5	Convergence Zone Detection coverage is 50%
FACT Coherent and Semicoherent	90		45.5	48.0	ZDC[2] 30%, 30-35.5 km
FACT Incoherent	90	32.5	45.5	51.0	
Gulf of Alaska	95		45.0	56.0	Convergence Zone Detection coverage is 40%
FACT Coherent and Semicoherent	95		45.0	51.0	ZDC 50%, 30-45 km; ZDC 50%, 51.5-59 km
FACT Incoherent	95	42.0	45.5	56.5	
Gulf of Alaska	100				ZDC[2] 30%, 30-45 km; ZDC 75%, 45-56 km; ZDC 15%,56-67 km
FACT Coherent and Semicoherent	100		45.0	51.0	ZDC 90%, 30-45 km; ZDC 60%, 51.5-67 km
FACT Incoherent	100	>67.0			
Gulf of Alaska	105				ZDC 70%, 30-45 km; ZDC 85%, 45-57 km; ZDC 35%, 57-67 km
FACT Coherent and Semicoherent	105				ZDC 95%, 30-51 km; ZDC 70%, 51-67 km
FACT Incoherent	105	>67.0			
Gulf of Alaska	110				ZDC 85%, 30-45 km; ZDC 95%, 45-57 km; ZDC 60%, 57-67 km
FACT Coherent and Semicoherent	110				ZDC 98%, 30-67 km
FACT Incoherent	110	>67.0			

1. R_c is the range to which detection coverage is continuous.

2. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.

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(C) Table IIH-12. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 107 (30-67 km) Experimental Data and FACT PL9D Model Results.
CASE X:
(Source Depth = 1067 m, Receiver Depth = 305 m, Frequency = 2.5 kHz)
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c[1]	CZ Start	CZ End	
Gulf of Alaska	90		44.0	52.5	Convergence Zone Detection coverage is 20% CZ is double lobed with gap of 2 km
FACT[3]	90		43.5	51.5	
Gulf of Alaska	95				ZDC[2] 10%, 30-44.5 km; ZDC 40%, 44.5-54.5 km; ZDC 5%, 54.5-67 km
FACT[3]	95	42.0	43.0	?	100% coverage, 43-67 km
Gulf of Alaska	100				ZDC 50%, 30-44.5 km; ZDC 85%, 44.5-54.5 km; ZDC 30%, 54.5-67 km
FACT[3]	100	>67.0			
Gulf of Alaska	105				ZDC 95%, 30-44.5 km; ZDC 98%, 44.5-54.5 km; ZDC 70%, 54.5-67 km
FACT[3]	105	>67.0			
Gulf of Alaska	110				100% coverage, 30-55 km; ZDC 95%, 55.5-67 km
FACT[3]	110	>67.0			

1. R_c = Range to which detection coverage is continuous.
2. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.
3. FACT coherent, semicoherent and incoherent outputs are identical in the interval of the Gulf of Alaska data (30-67 km).

(C) Table IIH-13. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 112B (2-19.5 km) Experimental Data and FACT PL9D Model Results.
CASE XI:
(Source Depth = 305 m, Receiver Depth = 30.5 m, Frequency = 2.5 kHz)
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c[1]	Range > R_c
Gulf of Alaska	75		ZDC[3] 50%, 2-6 km
FACT PL9D[2]	75		100% coverage, 2-8 km
Gulf of Alaska	80		ZDC 70%, 2-7 km
FACT PL9D[2]	80		100% coverage, 2-13 km
Gulf of Alaska	85		ZDC 90%, 2-6.5 km; ZDC 30%, 6.5-11 km; ZDC 5%, 11-19.5 km
FACT PL9D[2]	85		100% coverage, 2-14 km & 16.5-19.5 km
Gulf of Alaska	90		ZDC 98%, 2-6.5 km; ZDC 60%, 6.5-11 km; ZDC 35%, 11-19.5 km
FACT PL9D[2]	90	14	ZDC 80%, 14-19.5 km
Gulf of Alaska	95	6.5	ZDC 90%, 6.5-11 km; ZDC 60%, 11-19.5 km
FACT PL9D[2]	95	>19.5	
Gulf of Alaska	100	7.0	ZDC 90%, 7-19.5 km
FACT PL9D[2]	100	>19.5	

1. R_c = Range to which detection coverage is continuous.

2. FACT PL9D coherent, semicoherent, and incoherent outputs are identical over the Gulf of Alaska data interval (2-19.5 km).

3. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.

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(C) Table IIH-14. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 112B (2-19.5 km) Experimental Data and FACT PL9D Model Results.
CASE XII:
(Source Depth = 305 m, Receiver Depth = 305 m, Frequency = 2.5 kHz)
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c [1]	Range > R_c
Gulf of Alaska	70		ZDC[3] 30%, 2-3 km
FACT PL9D[2]	70	4.5	100% coverage, 15-16.5 km
Gulf of Alaska	75	2.0	ZDC 30%, 2-7 km
FACT PL9D[2]	75	8.5	100% coverage, 13-18 km
Gulf of Alaska	80	3.0	ZDC 85%, 2-7 km; ZDC 10%, 7.5-15.5 km; ZDC 40%, 15.5-19.5 km
FACT PL9D[2]	80	>19.5	
Gulf of Alaska	85	5.5	ZDC 40%, 5.5-19.5 km
FACT PL9D[2]	85	>19.5	
Gulf of Alaska	90	6.5	ZDC 65%, 6.5-19.5 km
FACT PL9D[2]	90	>19.5	
Gulf of Alaska	95	9.5	ZDC 90%, 10-14 km; 100% coverage, 14-19.5 km
FACT PL9D	95	>19.5	

1. R_c = Range to which detection range is continuous.
2. FACT PL9D coherent, semicoherent, and incoherent outputs are identical.
3. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.

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(C) Table IIH-15. Detection Range in km as a Function of Figure of Merit (FOM) in dB for Gulf of Alaska, Run 112A (15-58 km) Experimental Data and FACT PL9D Model Results.
CASE XIII:
(Source Depth = 305 m, Receiver Depth = 30.5 m, Frequency = 2.5 kHz)
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c[1]	Range > R_c
Gulf of Alaska	85		ZDC[3] 65%, 30-32 km
FACT PL9D[2]	85		100% coverage, 22-23.5, 30-33.5, 37.5-39 km
Gulf of Alaska	90		ZDC[3] 15%, 22.5-55 km
FACT PL9D[2]	90		100% coverage, 21-42 & 50-51 km
Gulf of Alaska	95		ZDC 50%, 22.5-58 km
FACT PL9D[2]	95		100% coverage, 18-53.5 & 54-58 km
Gulf of Alaska	100		ZDC 15%, 15-22 km; ZDC 70%, 22-58 km
FACT PL9D[2]	100	>58	
Gulf of Alaska	105		ZDC 50%, 15-24 km; ZDC 95%, 24-58 km
FACT PL9D[2]	105	>58	
Gulf of Alaska	110		ZDC 80%, 15-24 km; ZDC 98%, 24-58 km
FACT PL9D[2]	110	>58	

1. R_c = Range to which detection coverage is continuous.
2. FACT PL9D coherent, semicoherent and incoherent outputs are insignificantly different over the Gulf of Alaska data interval (15-58 km).
3. ZDC - Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.

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(C) Table IIH-16. Detection Range in km as a Function of
Figure of Merit (FOM) in dB for Gulf of Alaska,
Run 112A (15-58 km) Experimental Data and
FACT PL9D Model Results.
CASE XIV:
(Source Depth = 305 m, Receiver Depth = 305 m, Frequency = 2.5 kHz)
Bottom Loss: FNOC Type 6

DATA SET	FOM	R_c[1]	Range > R_c
Gulf of Alaska	80		ZDC[3] 10%, 15-33 km
FACT PL9D[2]	80		100% coverage, 15-18.5, 26.5-33.5, 45-47 km
Gulf of Alaska	85		ZDC 40%, 15-33 km; ZDC 10%, 33-45 km
FACT PL9D[2]	85	24.0	100% coverage, 26-37, 40-41, & 42-49.5 km
Gulf of Alaska	90		ZDC 80%, 15-33 km; ZDC 40%, 33-47 km; ZDC 20%, 47-58 km
FACT PL9D[2]	90	55.0	
Gulf of Alaska	95		ZDC 95%, 15-33 km; ZDC 80%, 33-47 km; ZDC 50%, 47-58 km
FACT PL9D[2]	95	>58.0	
Gulf of Alaska	100		ZDC 98%, 15-33 km; ZDC 95%, 33-47 km; ZDC 85%, 47-58 km
FACT PL9D[2]	100	>58.0	
Gulf of Alaska	105		100% coverage, 15-40 km; ZDC 90%, 40-58 km
FACT PL9D[2]	105	>58.0	

1. R_c = Range to which detection coverage is continuous.

2. FACT PL9D coherent, semicoherent and incoherent outputs are identical.

3. ZDC = Zonal Detection Coverage in percentage of the indicated range interval over which detection is possible.

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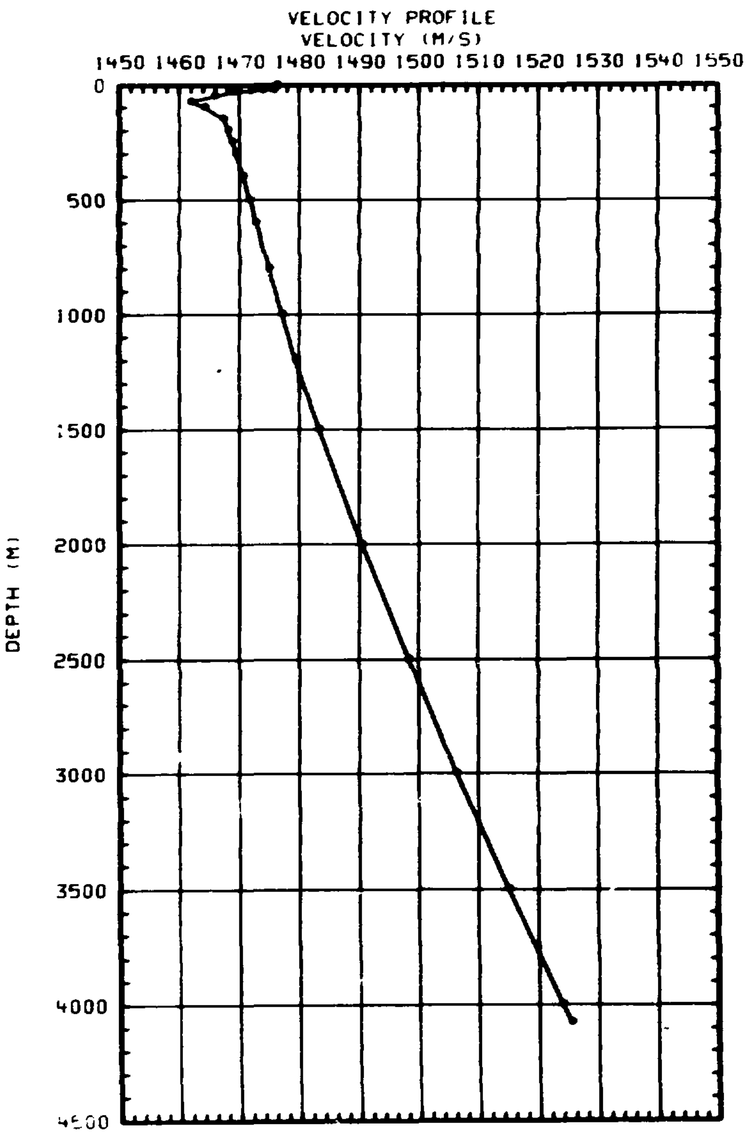
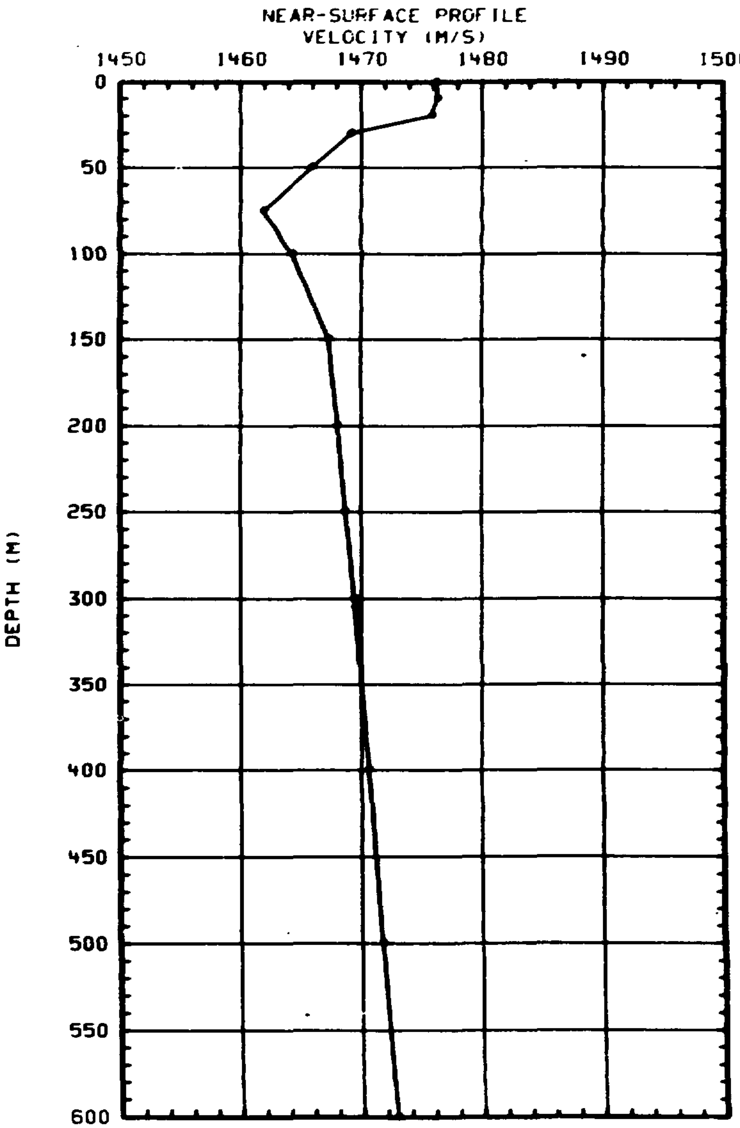


DEPTH	VELOCITY
0.0	1476.20
10.0	1476.30
20.0	1475.80
30.0	1469.20
30.5	1469.12
50.0	1465.90
75.0	1461.90
100.0	1464.20
150.0	1467.30
200.0	1468.00
250.0	1468.70
300.0	1469.40
305.0	1469.46
400.0	1470.60
500.0	1471.70
600.0	1472.80
800.0	1474.90
1000.0	1477.10
1200.0	1479.40
1500.0	1483.20
2000.0	1490.40
2500.0	1498.30
3000.0	1506.40
3500.0	1515.00
4000.0	1523.90
4078.0	1525.40



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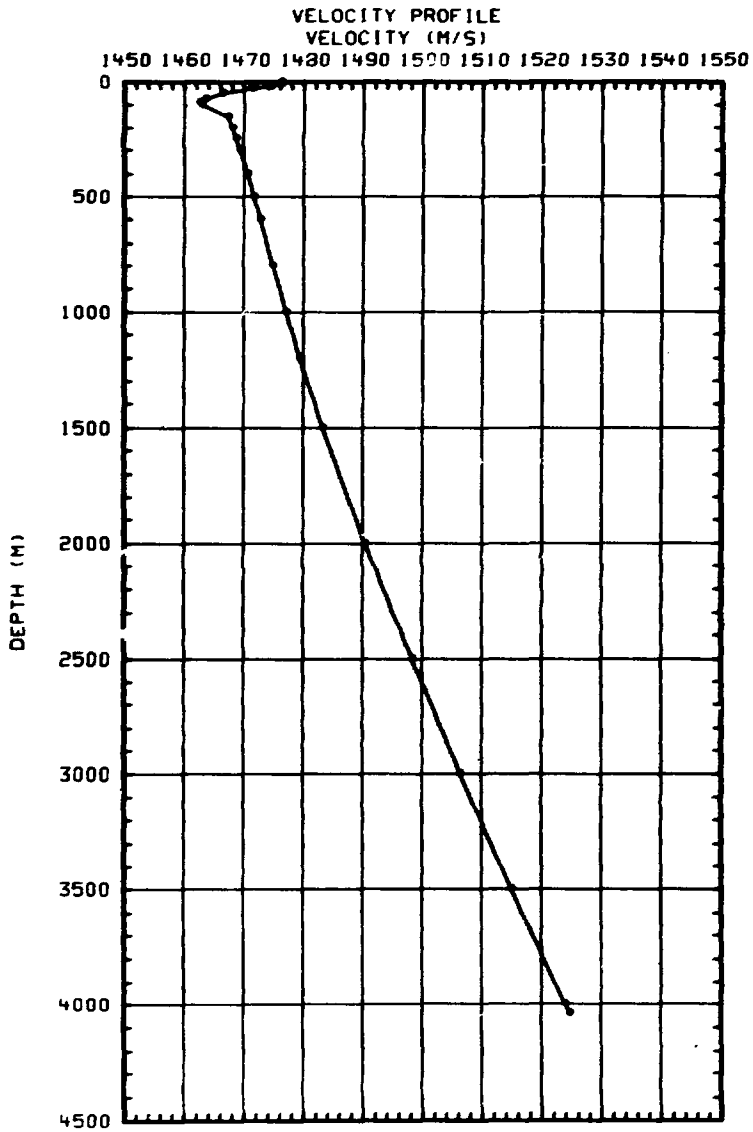
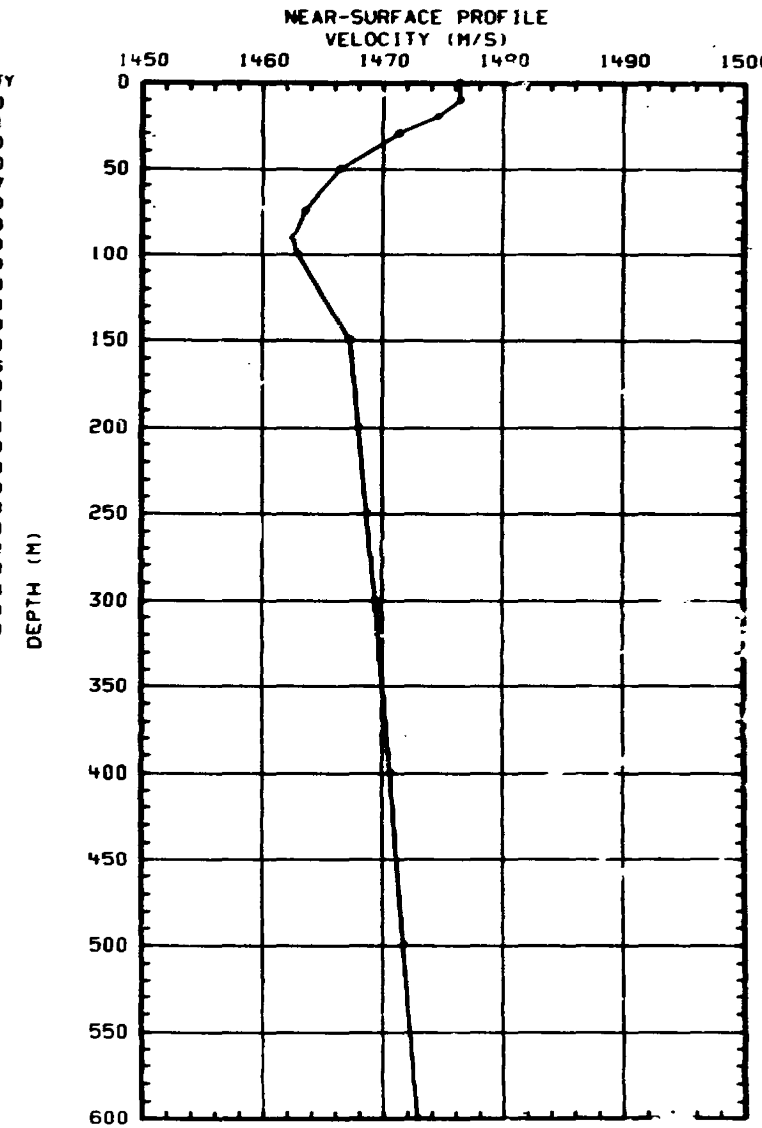
(U) Figure IIH-1. Gulf of Alaska Run 140 Sound Speed Profile



DEPTH	VELOCITY
0.0	1476.30
10.0	1476.31
20.0	1474.50
30.0	1471.40
30.5	1471.27
50.0	1466.40
75.0	1463.50
90.0	1462.50
100.0	1462.90
150.0	1467.30
200.0	1468.00
250.0	1468.70
300.0	1469.40
305.0	1469.46
400.0	1470.60
500.0	1471.70
600.0	1472.80
800.0	1474.90
1000.0	1477.10
1200.0	1479.40
1500.0	1483.20
2000.0	1490.40
2500.0	1498.30
3000.0	1506.40
3500.0	1515.00
4000.0	1523.90
4042.0	1524.70



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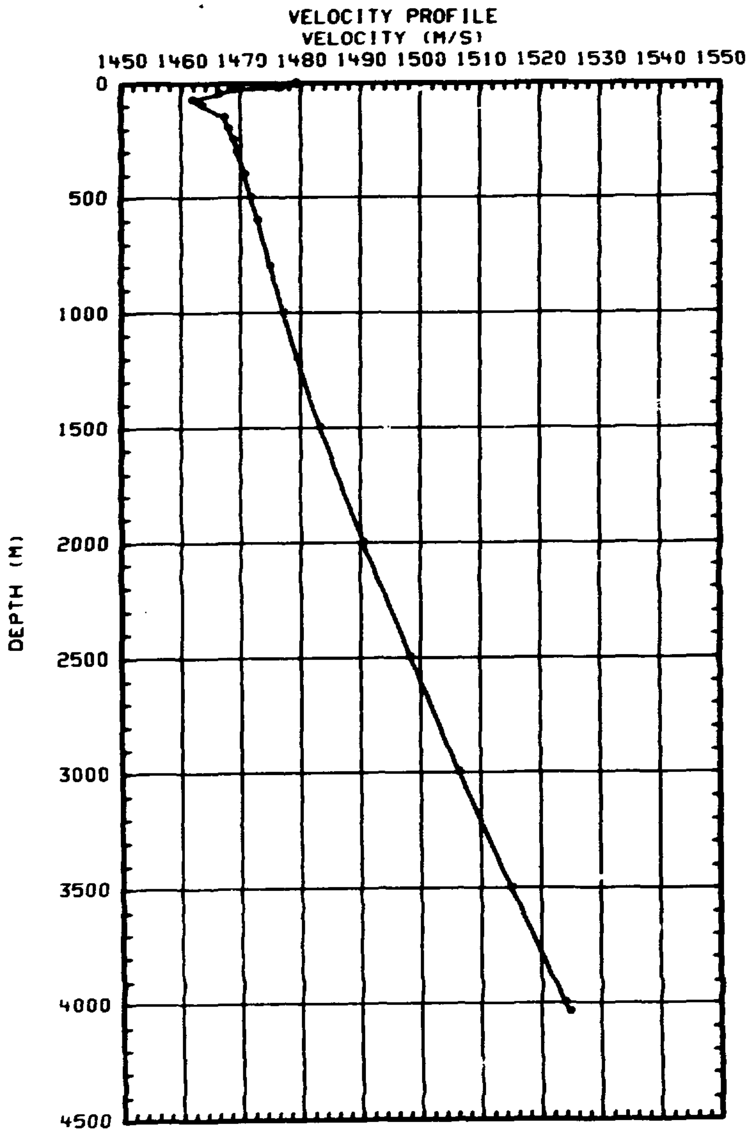
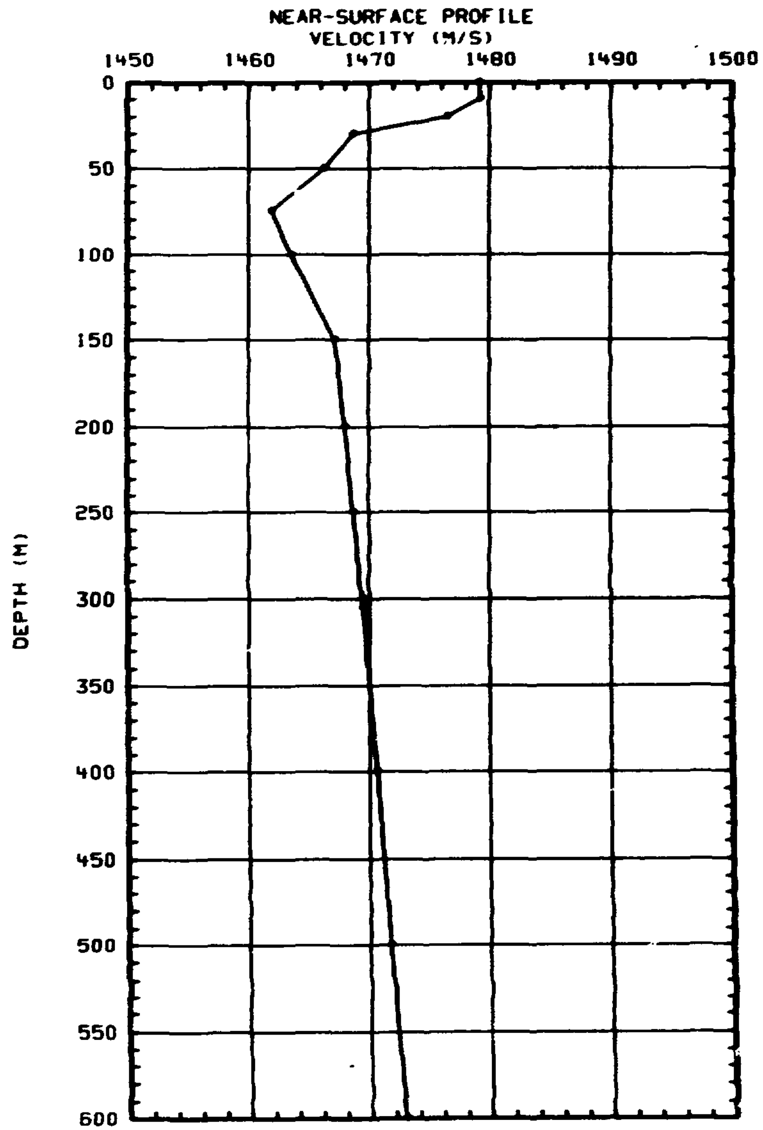
(U) Figure IIH-2. Gulf of Alaska Run 143 Sound Speed Profile



DEPTH	VELOCITY
0.0	1479.10
10.0	1479.20
20.0	1476.50
30.0	1468.70
30.5	1468.64
50.0	1466.30
75.0	1461.90
100.0	1463.50
150.0	1467.20
200.0	1468.00
250.0	1468.70
300.0	1469.40
305.0	1469.46
400.0	1470.60
590.0	1471.70
600.0	1472.80
800.0	1474.90
1000.0	1477.10
1200.0	1479.40
1500.0	1483.20
2000.0	1490.40
2500.0	1498.30
3000.0	1506.40
3500.0	1515.00
4000.0	1523.90
4042.0	1524.70



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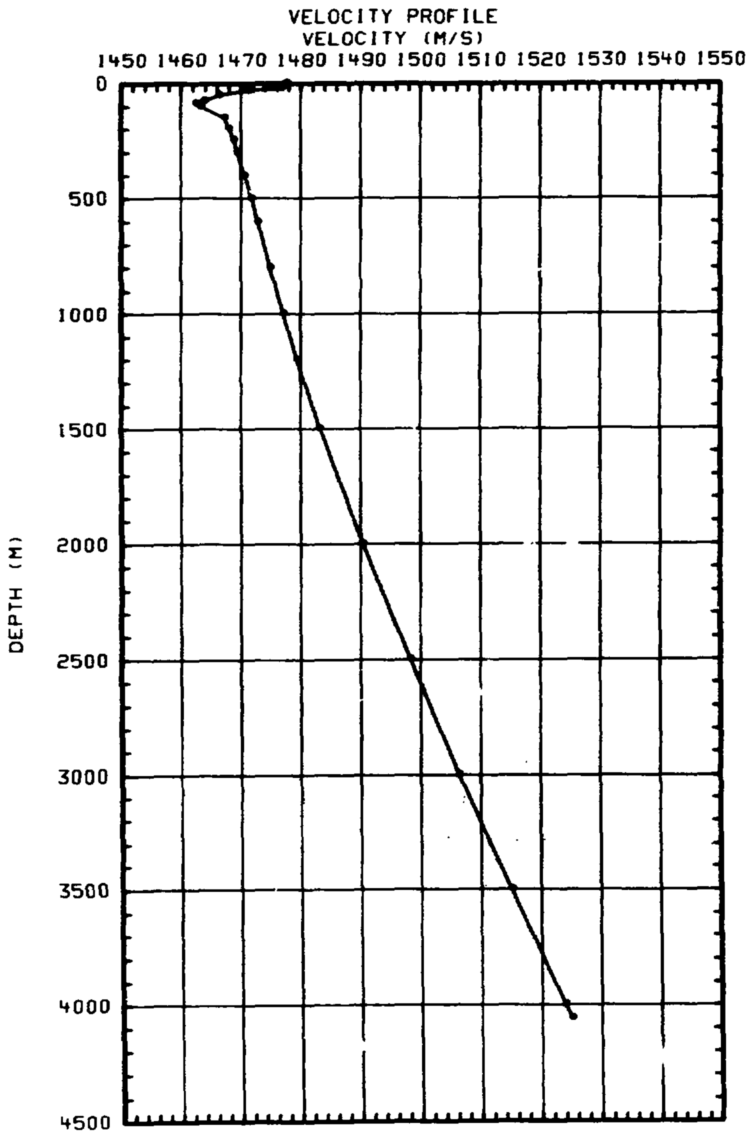
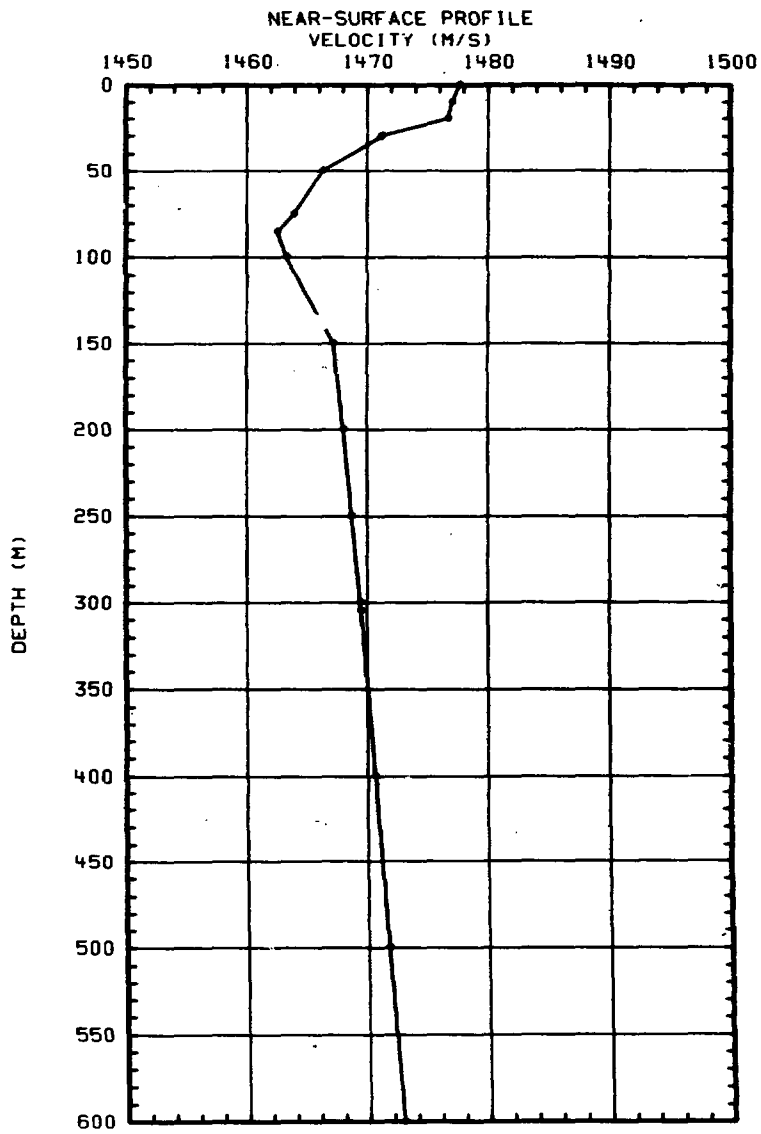
(U) Figure IIH-3. Gulf of Alaska Run 124 Sound Speed Profile



DEPTH	VELOCITY
0.0	1477.60
10.0	1477.00
20.0	1476.70
30.0	1471.20
30.5	1471.08
50.0	1466.30
75.0	1463.90
85.0	1462.50
100.0	1463.30
150.0	1467.20
200.0	1468.00
250.0	1468.70
300.0	1469.40
305.0	1469.46
400.0	1470.60
500.0	1471.70
600.0	1472.80
80C.0	1474.90
1000.0	1477.10
1200.0	1479.40
1500.0	1483.20
2000.0	1490.40
2500.0	1498.3C
3000.0	1506.40
3500.0	1515.00
4000.0	1523.90
4060.0	1525.00



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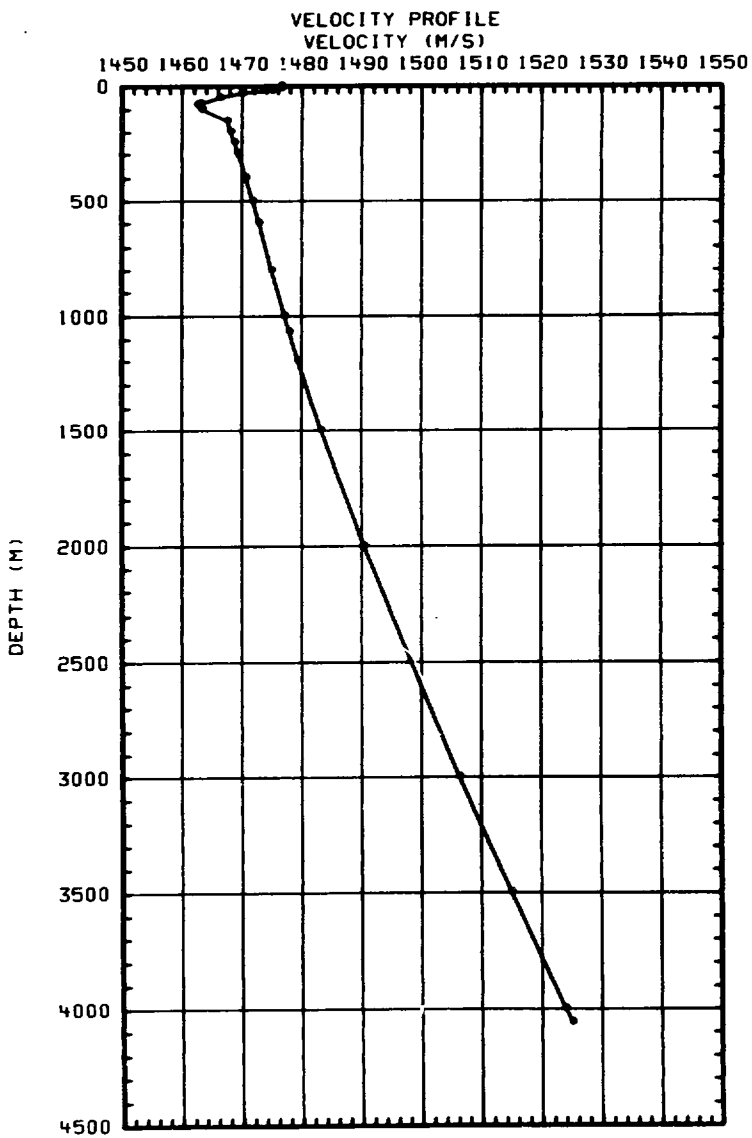
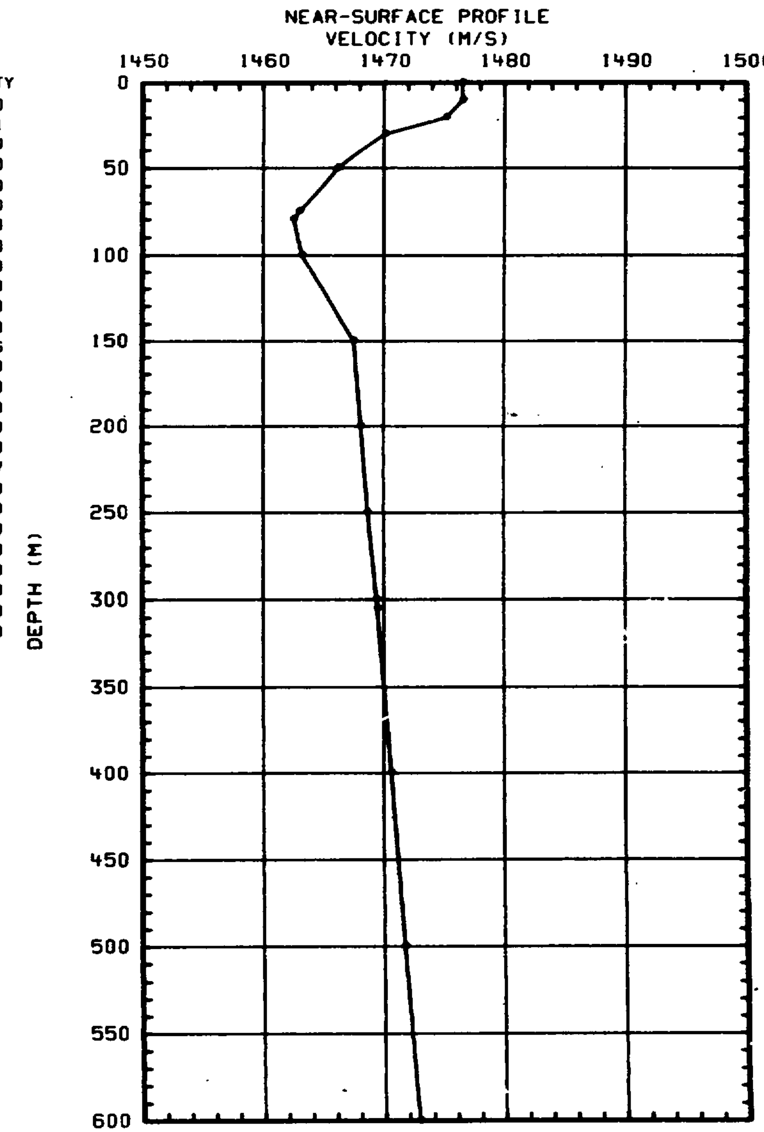
(U) Figure IIH-4. Gulf of Alaska Run 108 Sound Speed Profile



DEPTH	VELOCITY
0.0	1476.50
10.0	1476.51
20.0	1475.10
30.0	1470.10
50.0	1466.20
75.0	1463.00
80.0	1462.50
100.0	1463.20
150.0	1467.50
200.0	1468.10
250.0	1468.70
300.0	1469.40
305.0	1469.46
400.0	1470.60
500.0	1471.70
600.0	1472.80
800.0	1474.90
1000.0	1477.10
1067.0	1477.87
1200.0	1479.40
1500.0	1483.20
2000.0	1490.40
2500.0	1498.30
3000.0	1506.40
3500.0	1515.00
4000.0	1523.90
4060.0	1525.00



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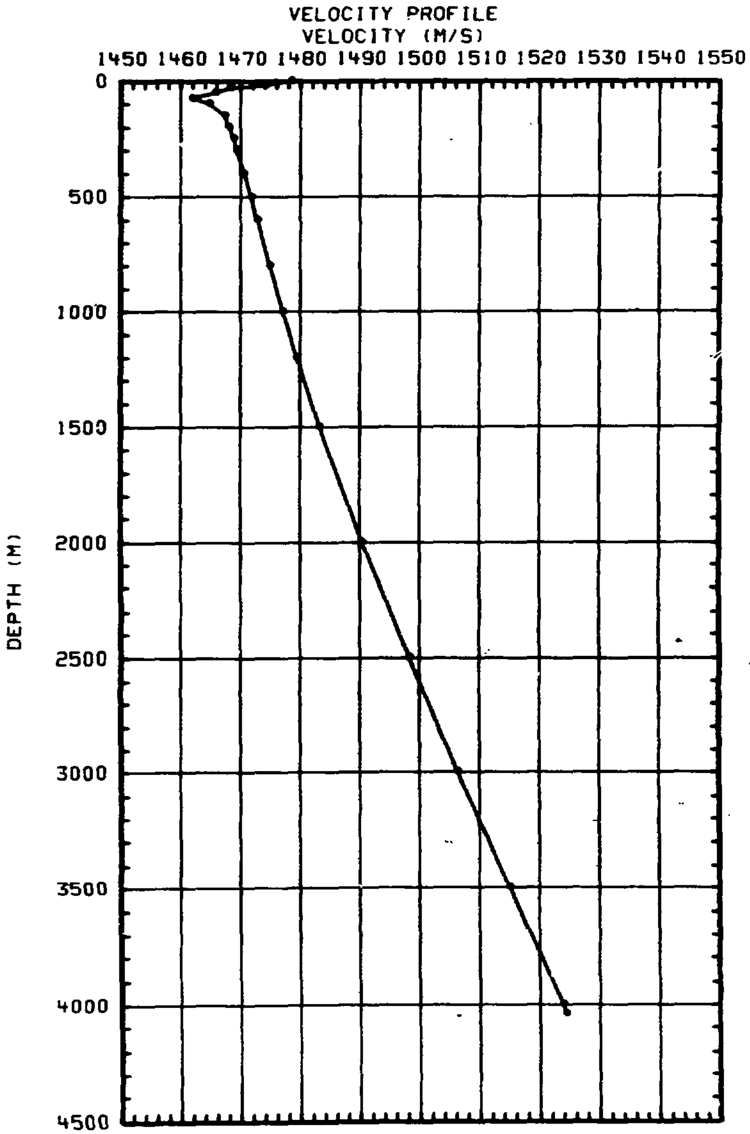
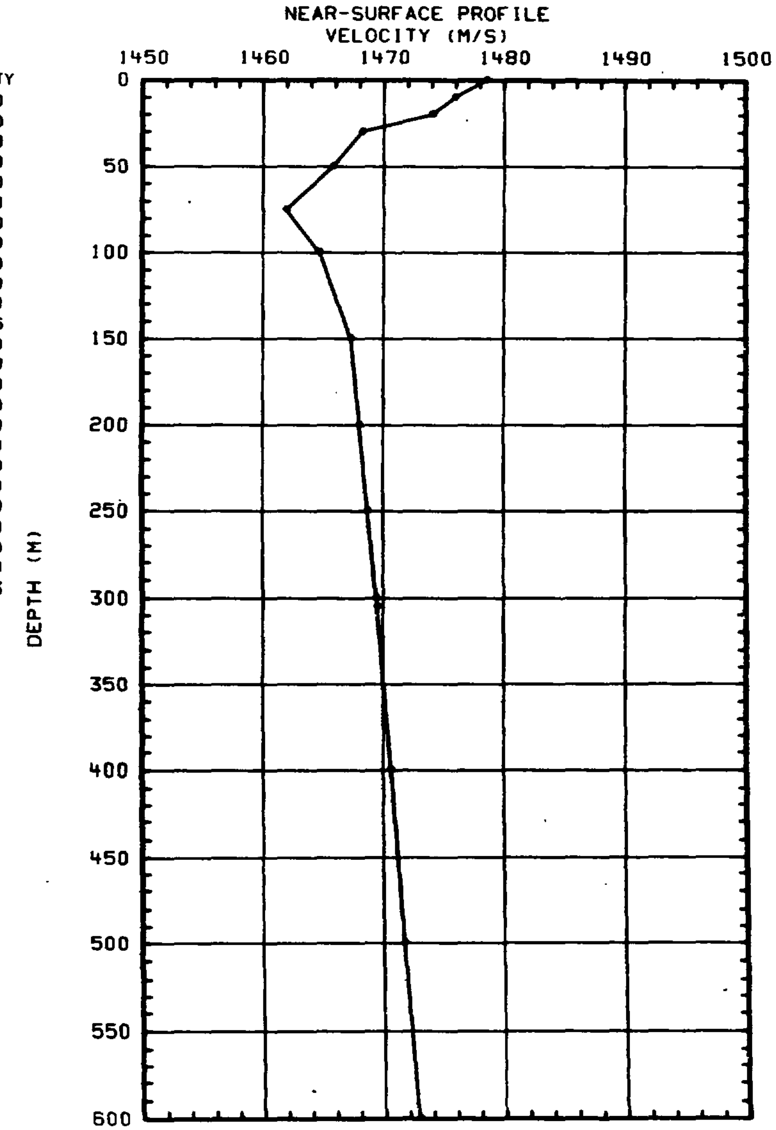
(U) Figure IIH-5. Gulf of Alaska Run 107 Sound Speed Profile



DEPTH	VELOCITY
0.0	1478.50
10.0	1475.90
20.0	1474.00
30.0	1468.20
50.0	1465.80
75.0	1461.90
100.0	1464.70
150.0	1467.30
200.0	1468.00
250.0	1468.70
300.0	1469.40
305.0	1469.46
400.0	1470.60
500.0	1471.70
600.0	1472.80
800.0	1474.90
1000.0	1477.10
1200.0	1479.40
1500.0	1483.20
2000.0	1490.40
2500.0	1498.30
3000.0	1506.40
3500.0	1515.00
4000.0	1523.90
4042.0	1524.33



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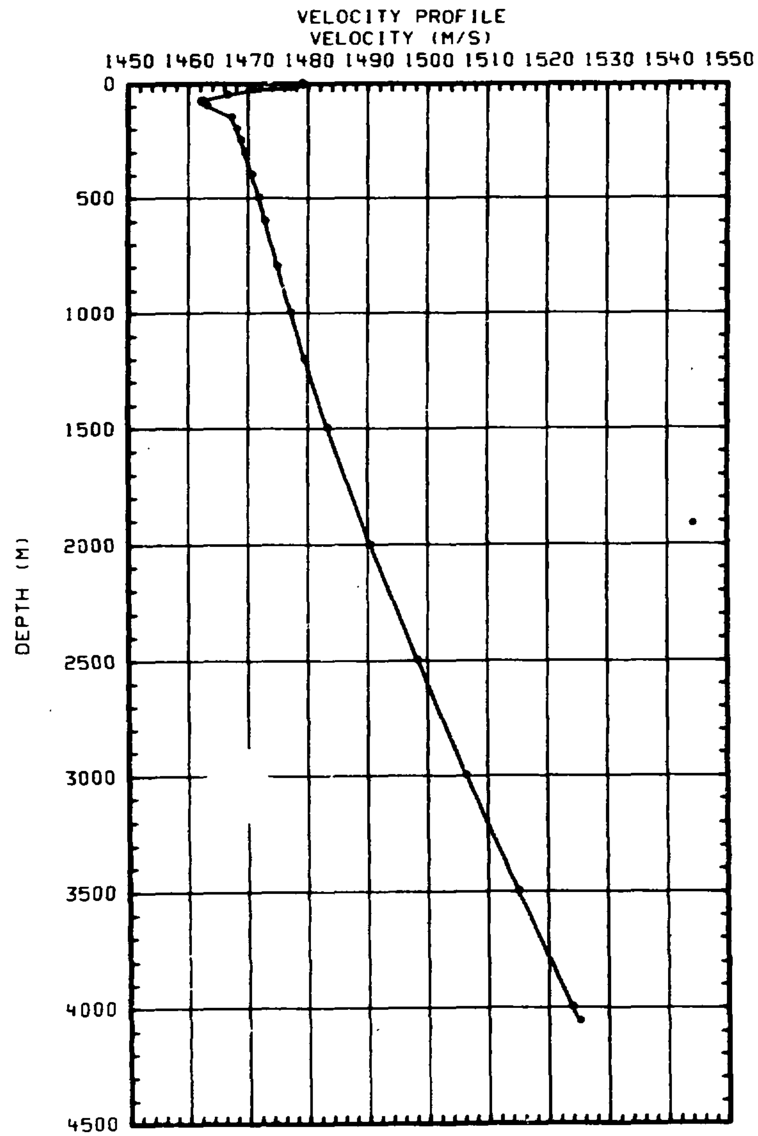
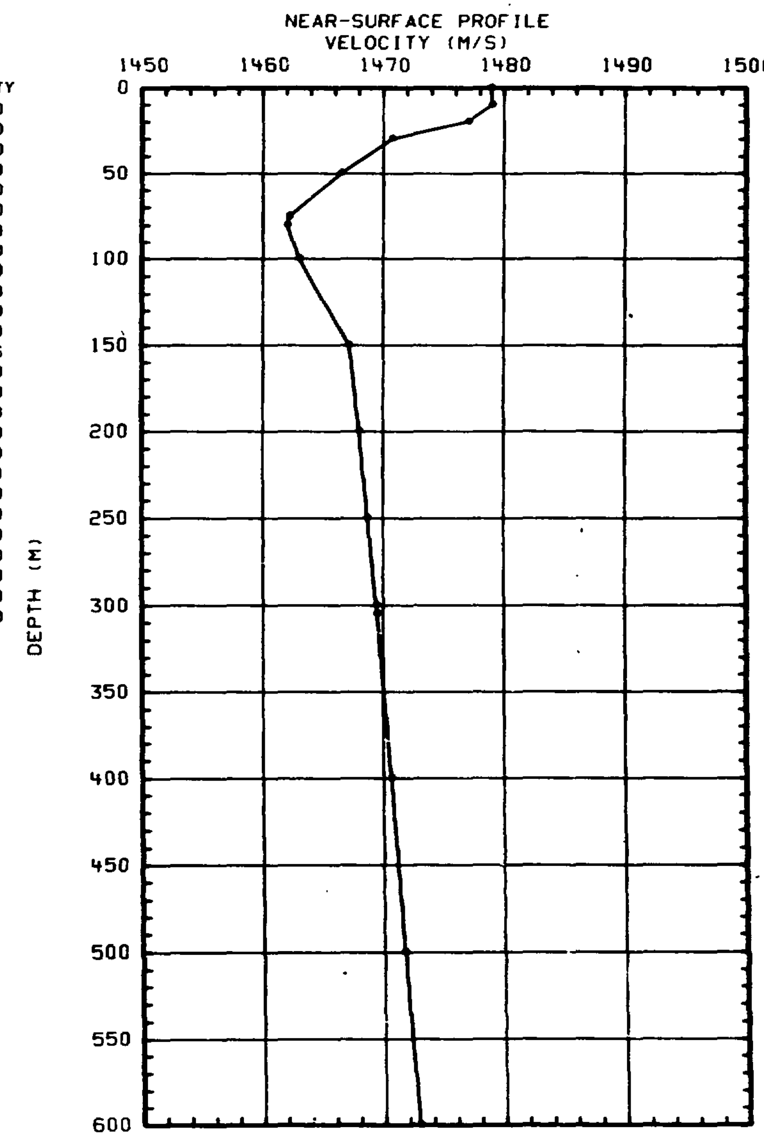
(U) Figure IIH-6. Gulf of Alaska Run 112B, Sound Speed Profile

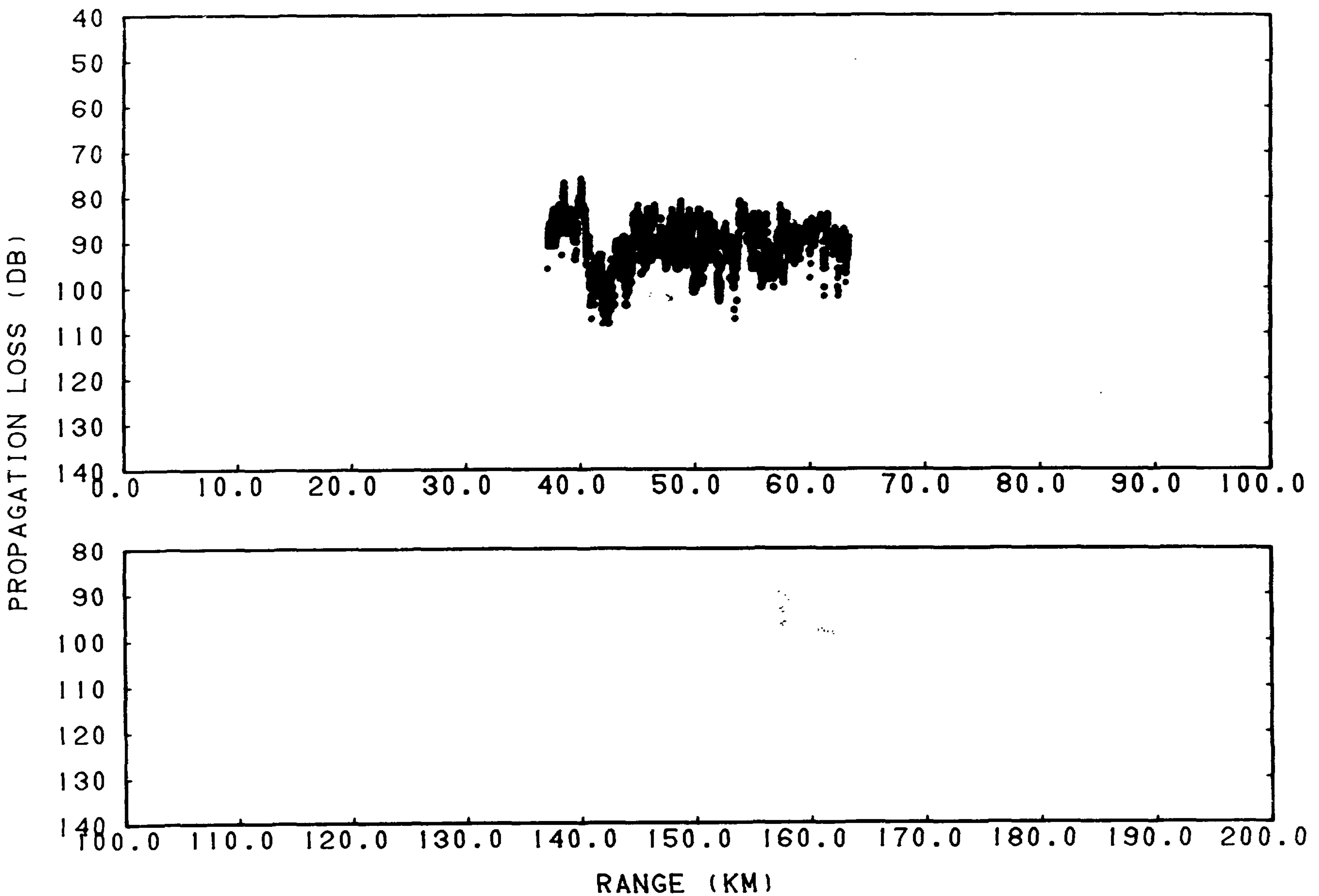


DEPTH	VELOCITY
0.0	1478.90
10.0	1479.00
20.0	1477.00
30.0	1470.70
50.0	1466.50
75.0	1462.20
80.0	1462.00
100.0	1463.00
150.0	1467.20
200.0	1468.00
250.0	1468.70
300.0	1469.40
305.0	1469.46
400.0	1470.60
500.0	1471.70
600.0	1472.80
800.0	1474.90
1000.0	1477.10
1200.0	1479.40
1500.0	1483.20
2000.0	1490.40
2500.0	1498.30
3000.0	1506.40
3500.0	1515.00
4000.0	1523.90
4060.0	1525.00



CONFIDENTIAL

(U) Figure IIH-7. Gulf of Alaska Run 112A Sound Speed Profile



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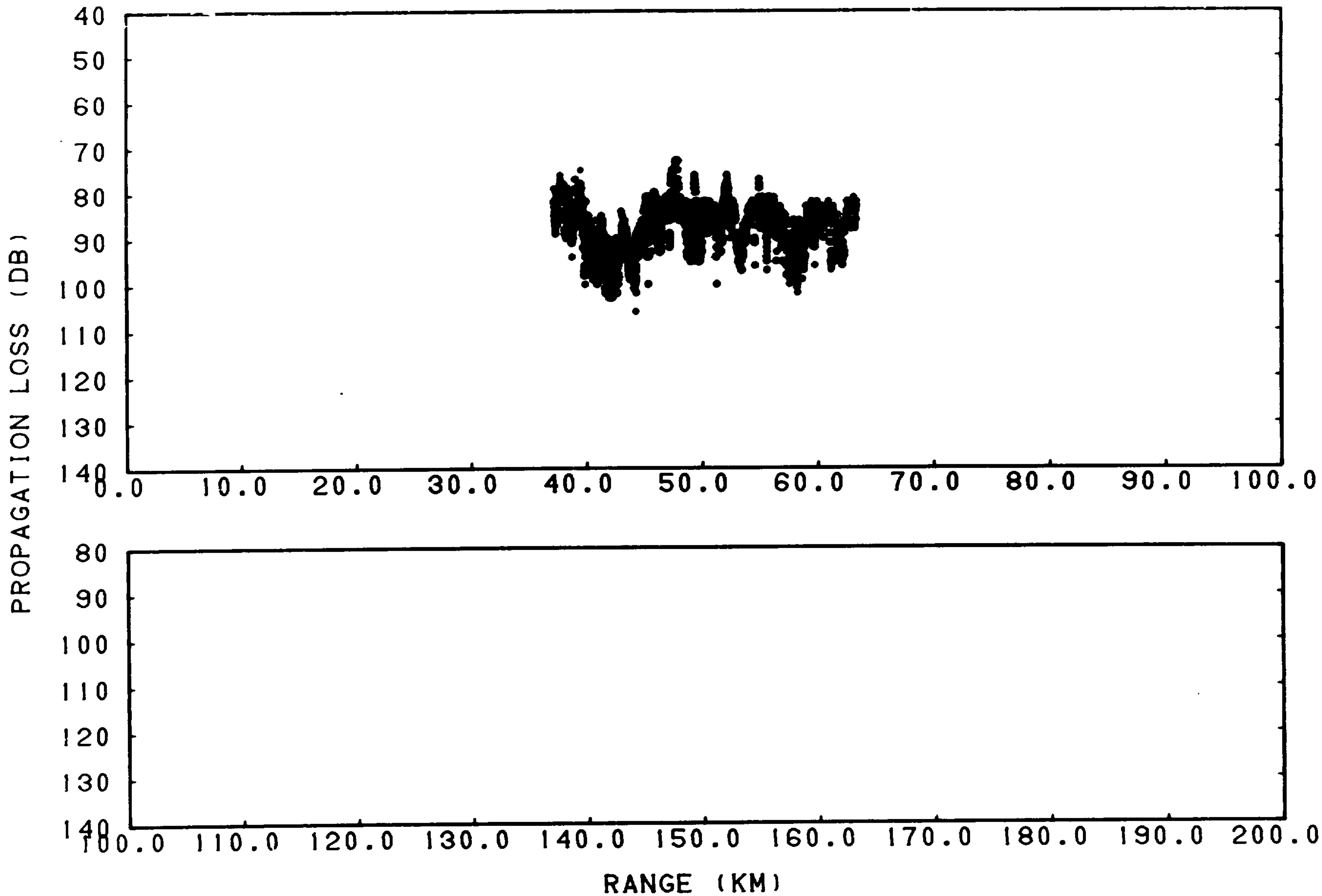
(C) Figure IIH-8. Gulf of Alaska, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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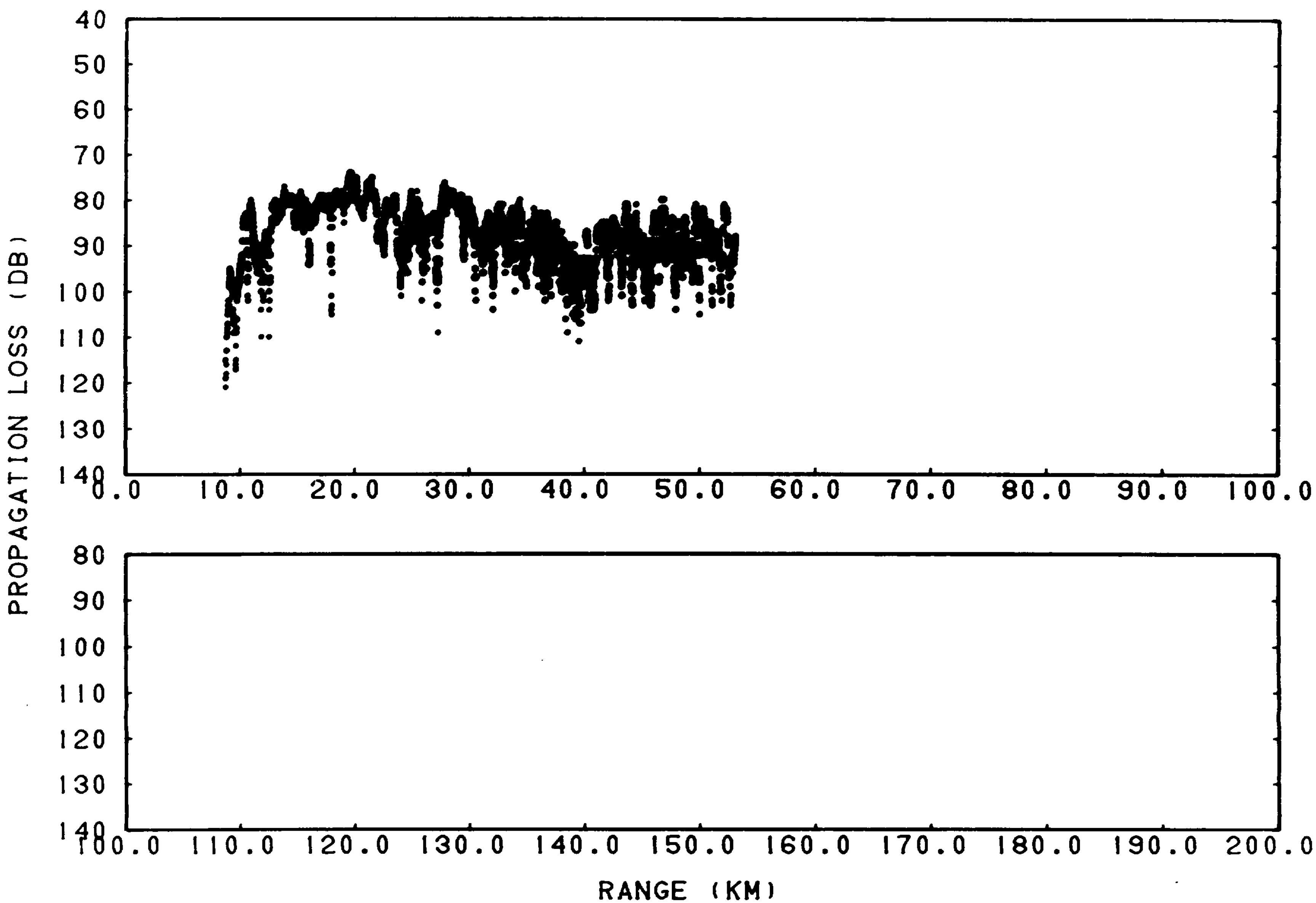
(C) Figure IIH-9. Gulf of Alaska, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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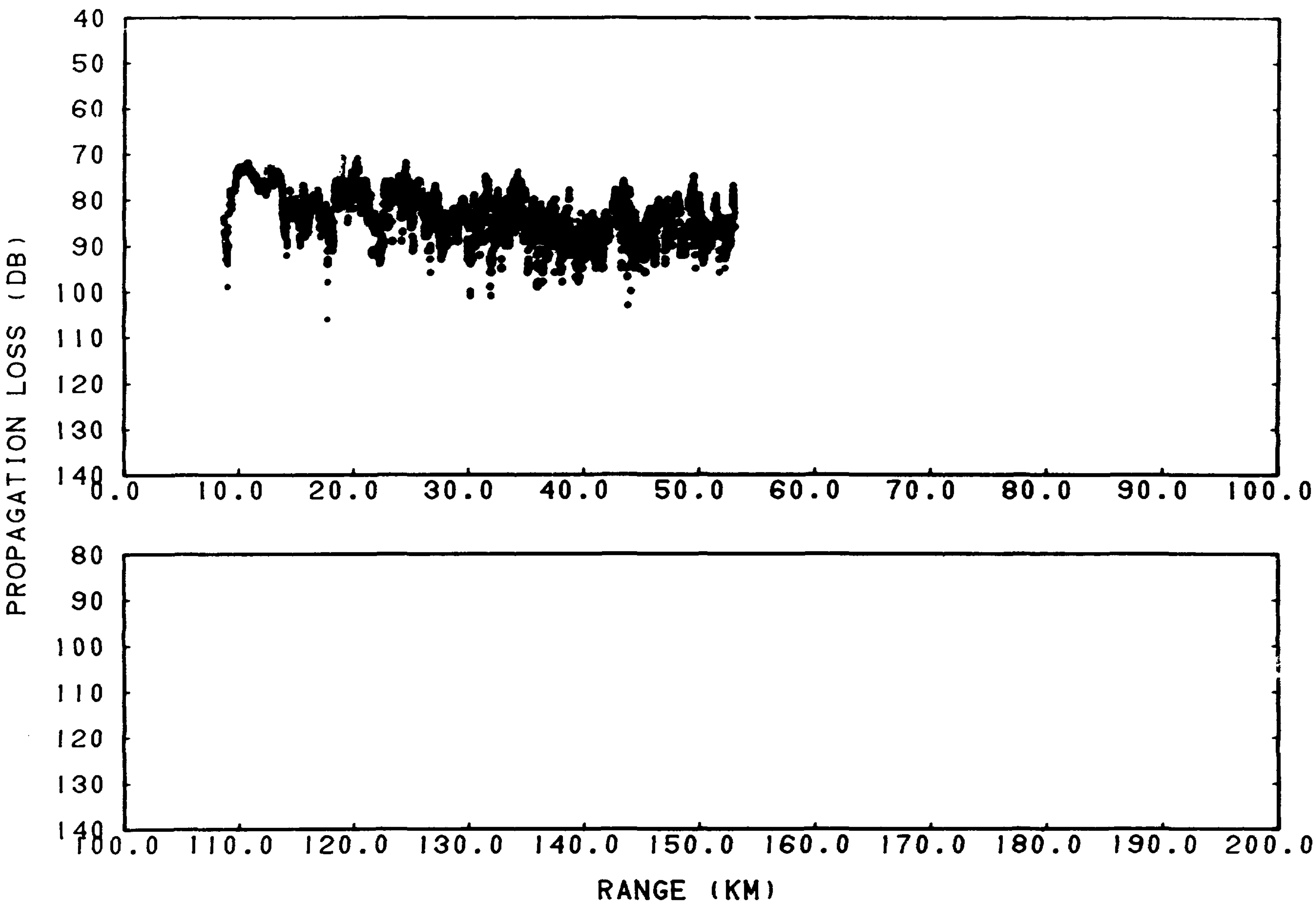
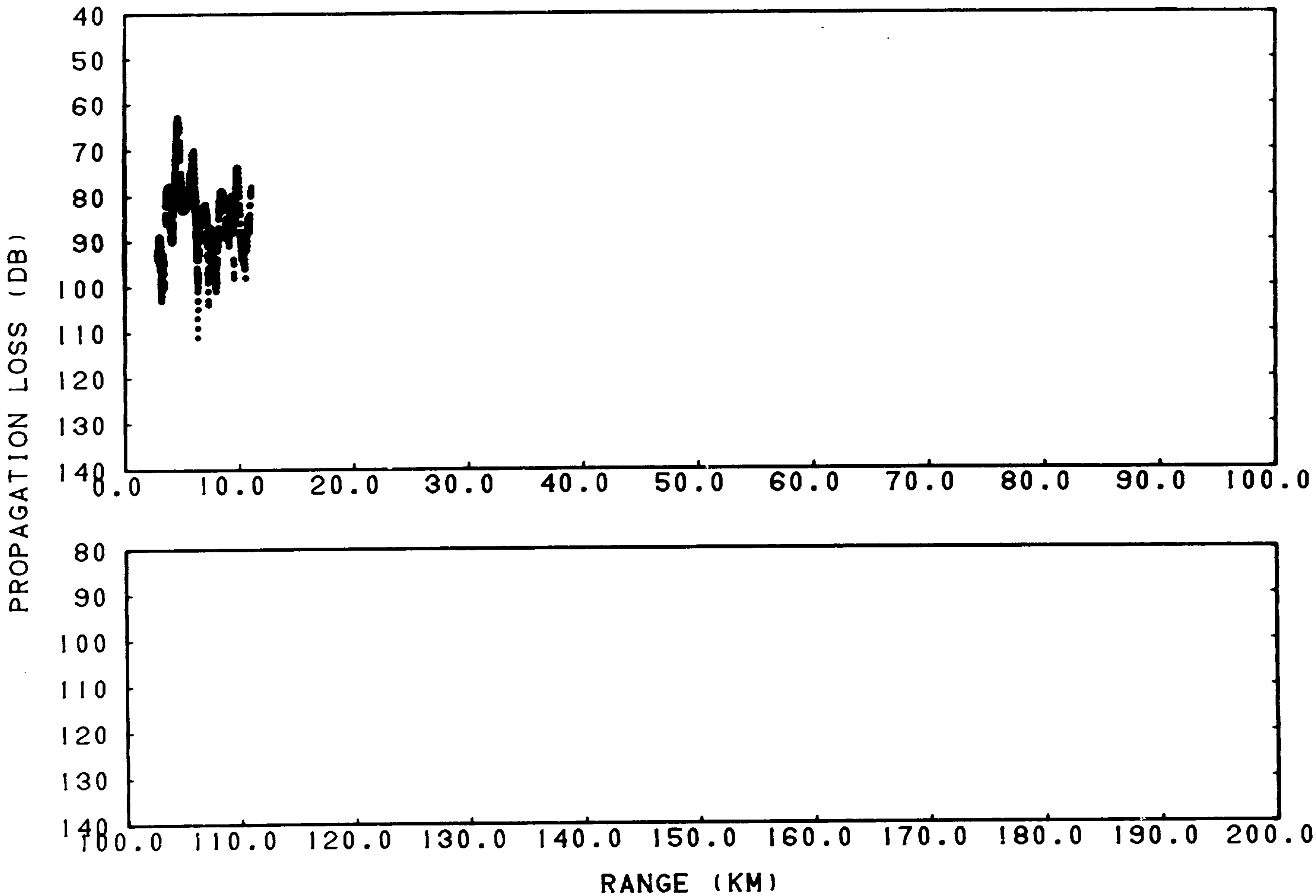
(C) Figure IIH-10. Gulf of Alaska, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



CONFIDENTIAL

(C) Figure IIH-11. Gulf of Alaska, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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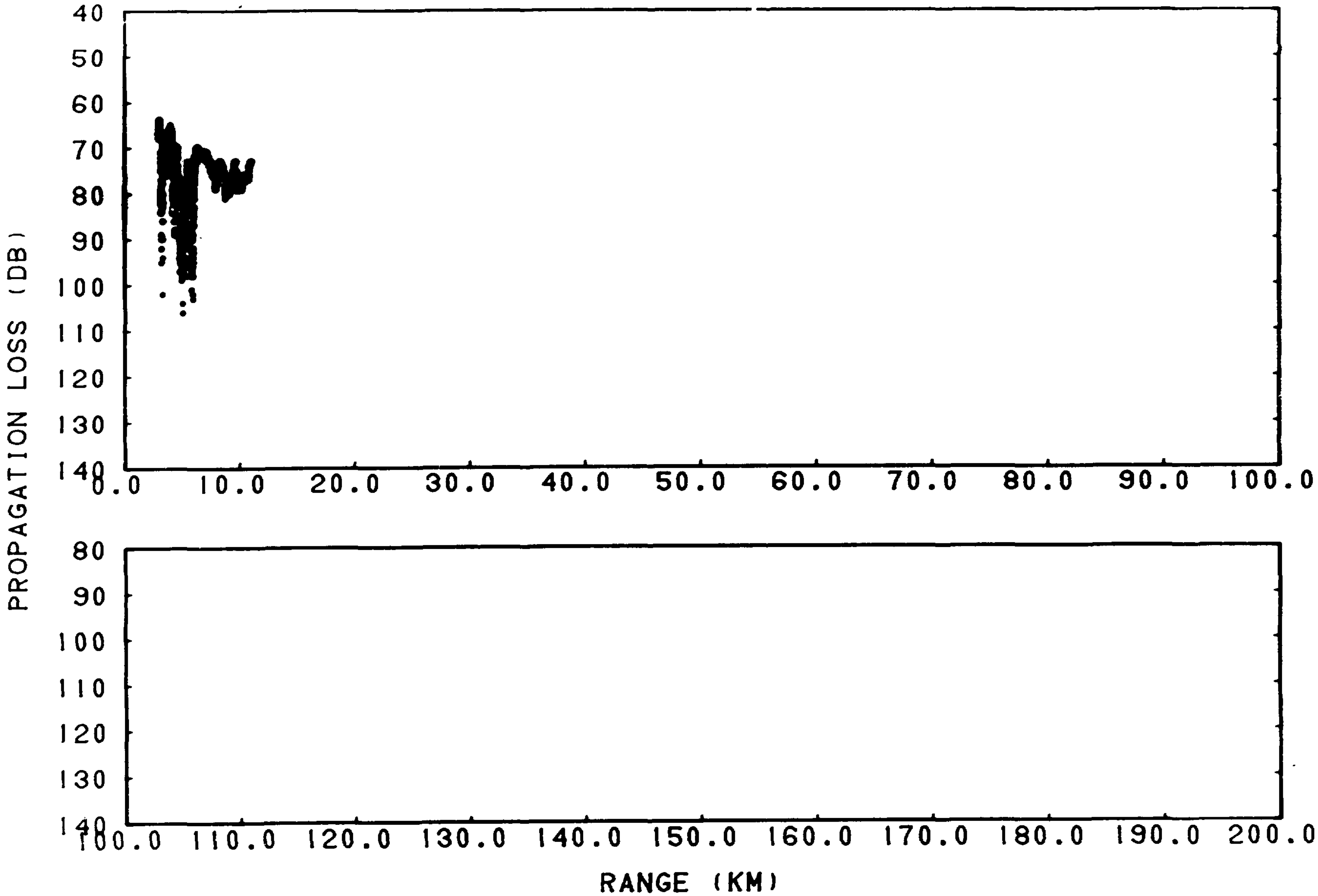
(C) Figure IIH-12. Gulf of Alaska, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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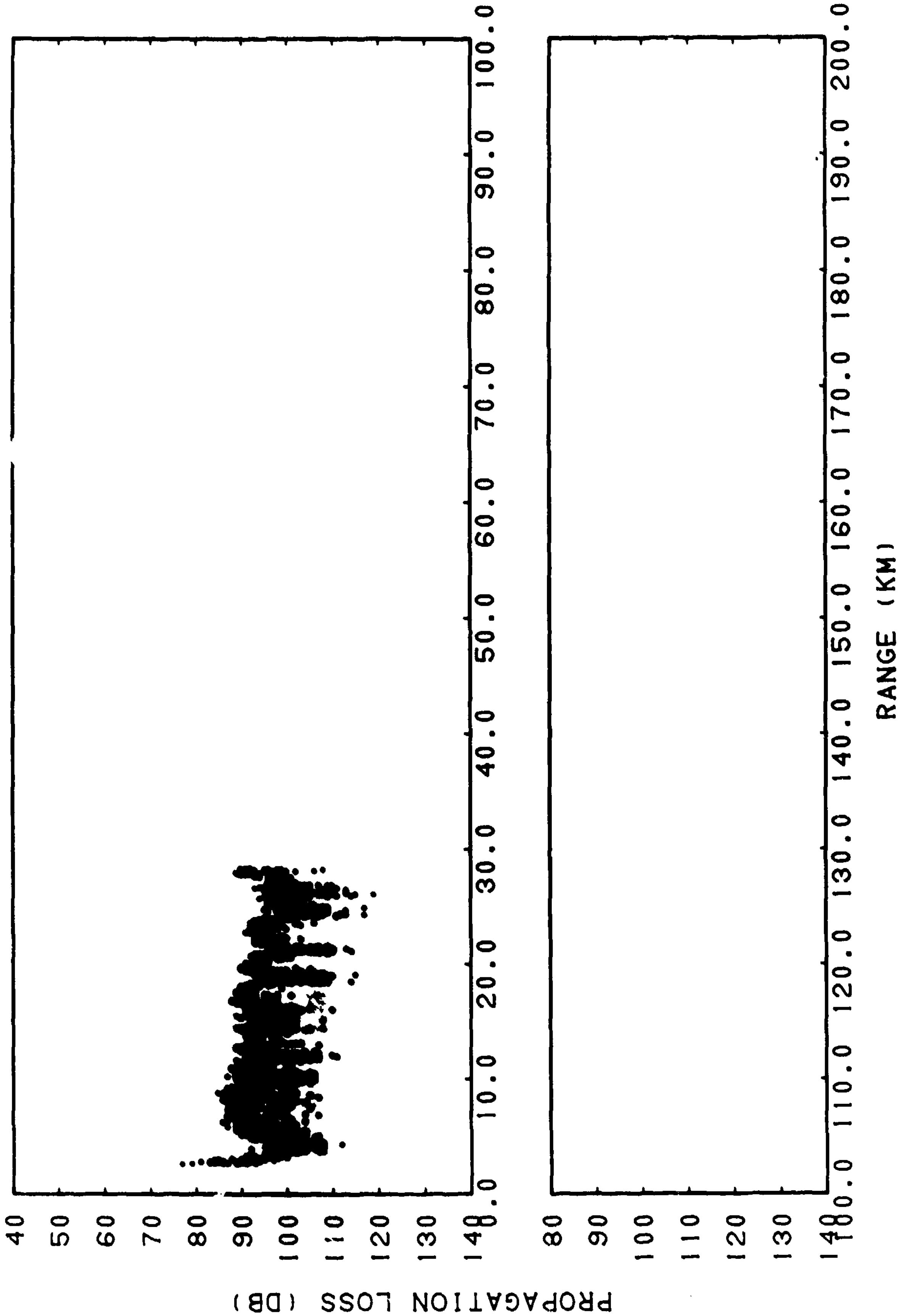
(C) Figure IIH-13. Gulf of Alaska, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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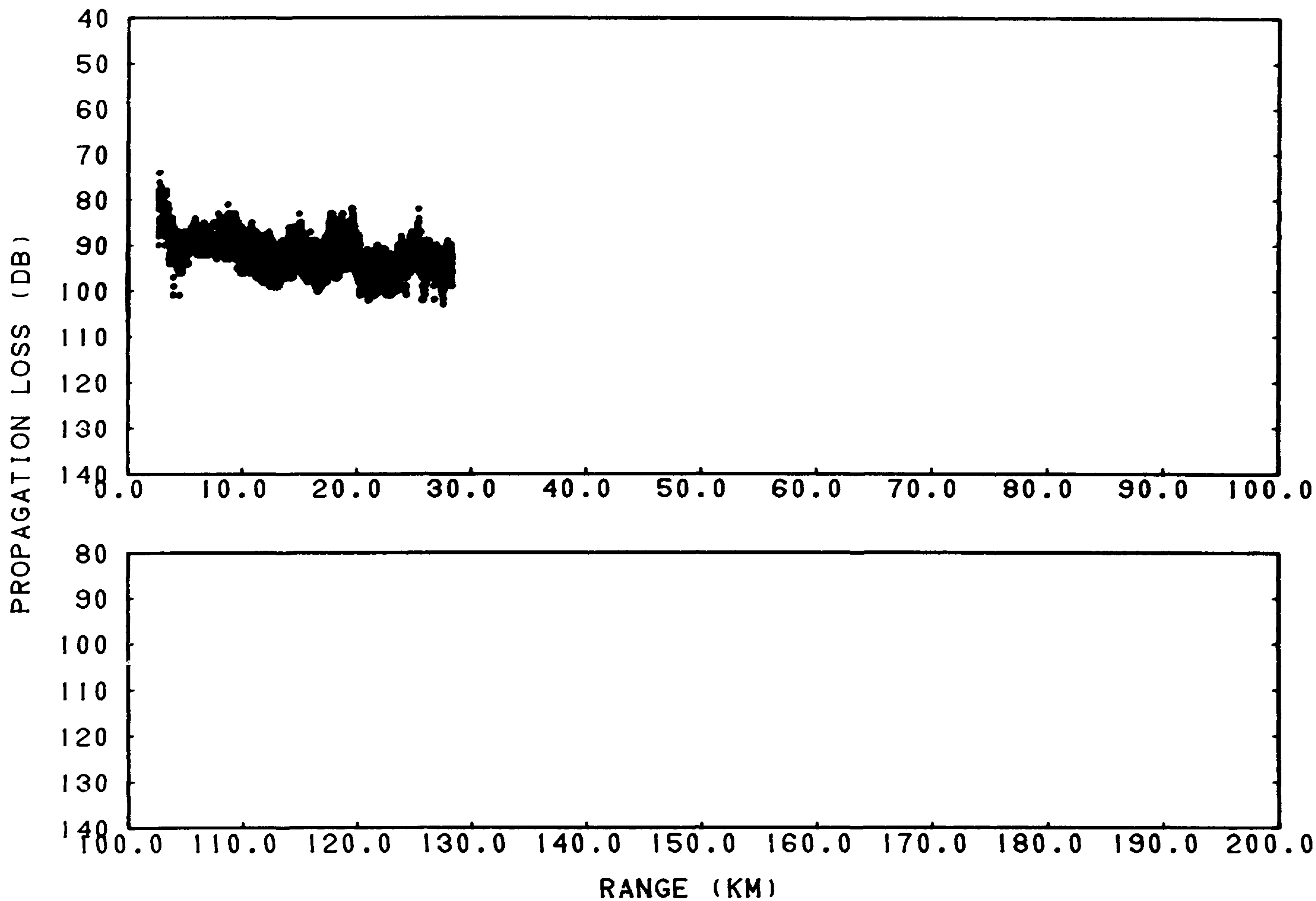
(C) Figure IIH-14. Gulf of Alaska, Run 108, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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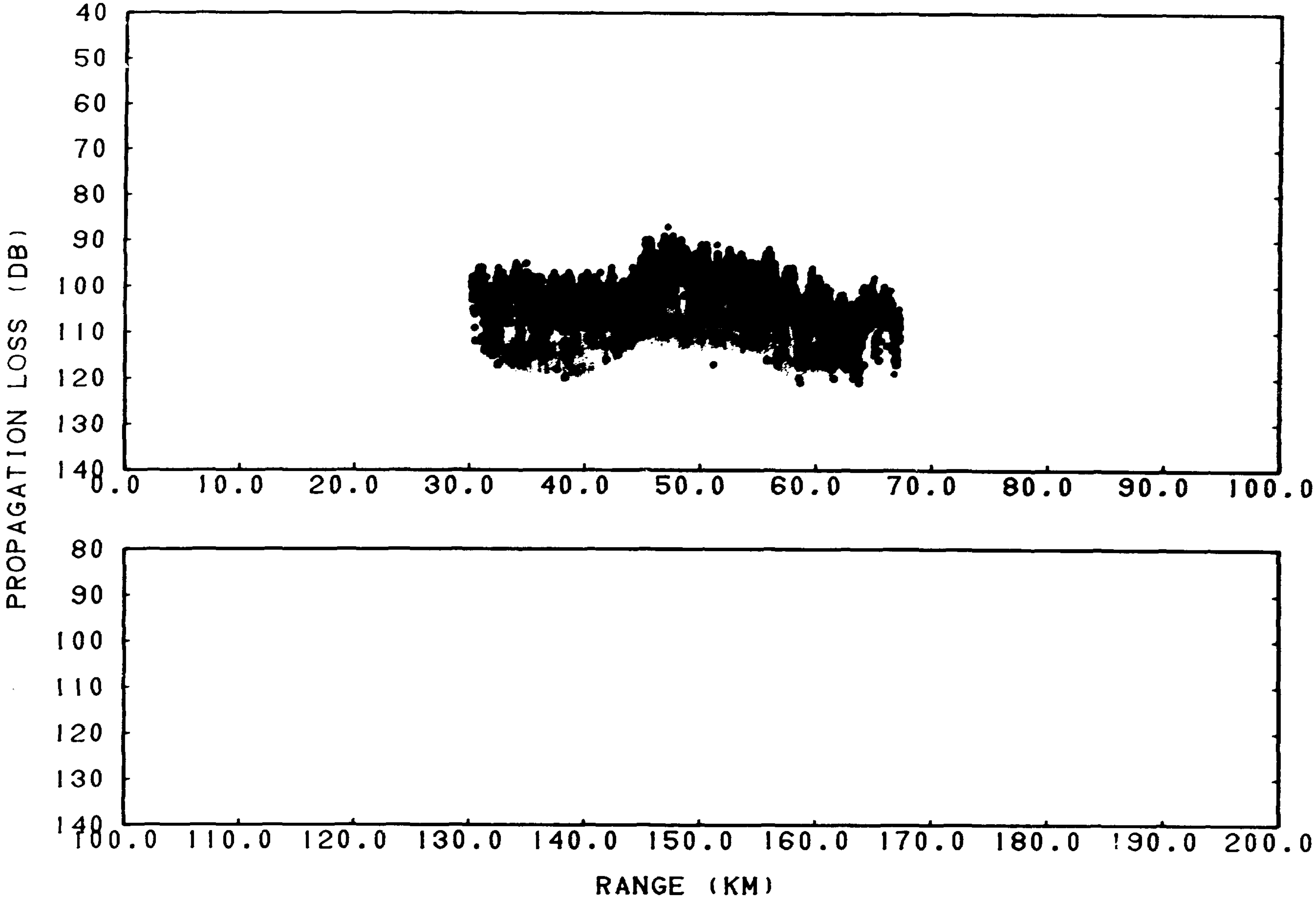
(C) Figure IIH-15. Gulf of Alaska, Run 108, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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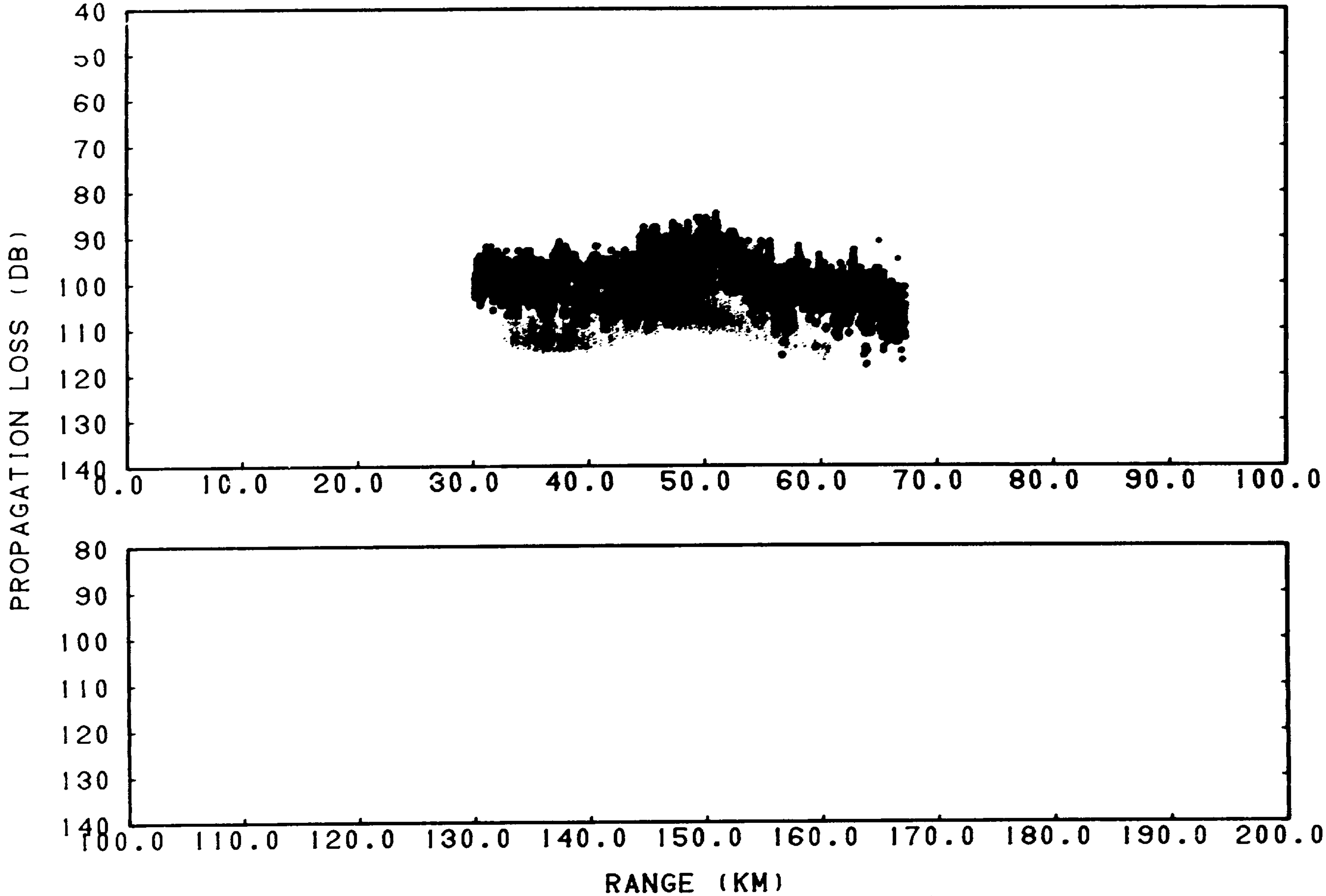
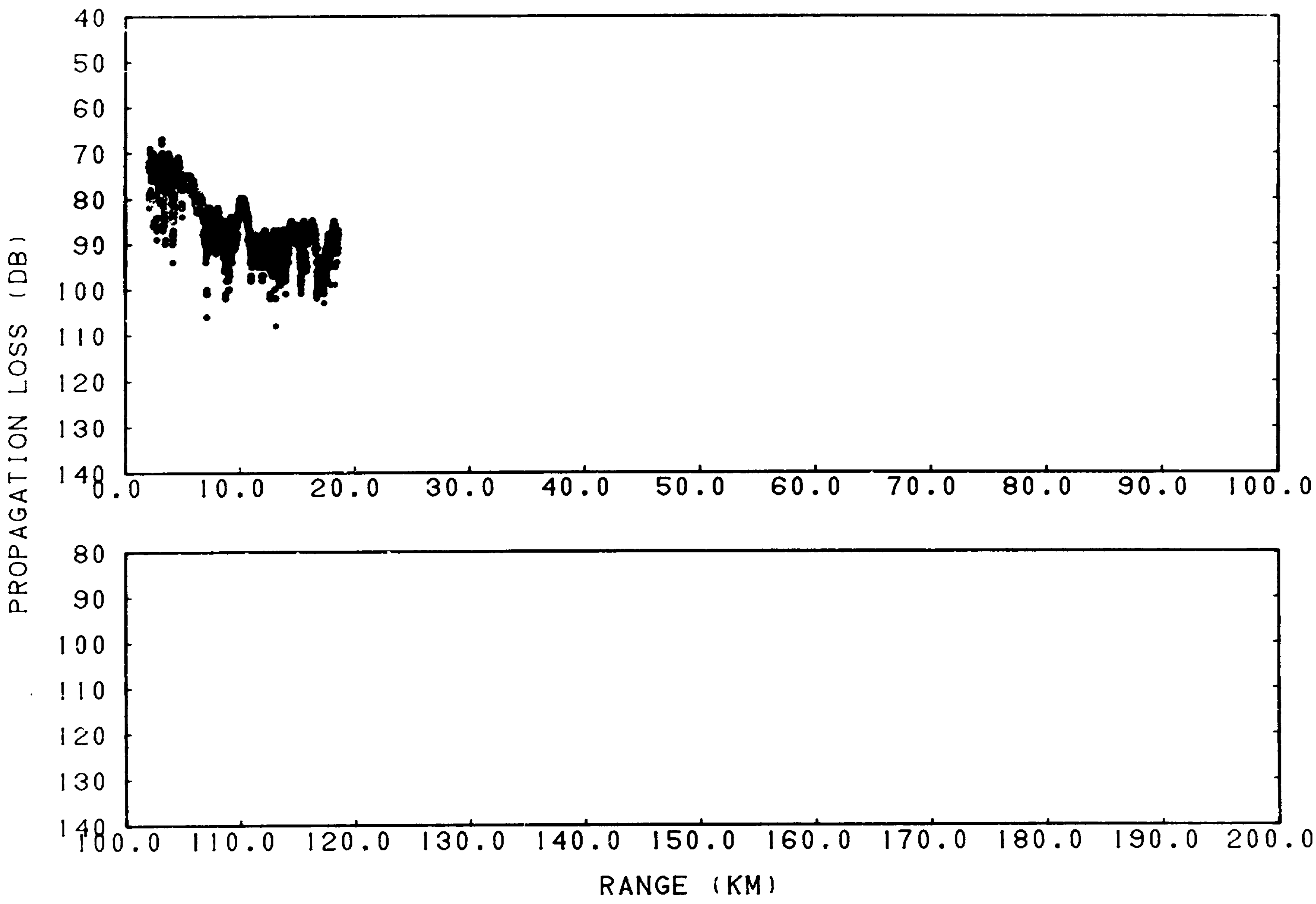
(C) Figure IIH-16. Gulf of Alaska, Run 107, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



CONFIDENTIAL

(C) Figure IIH-17. Gulf of Alaska, Run 107, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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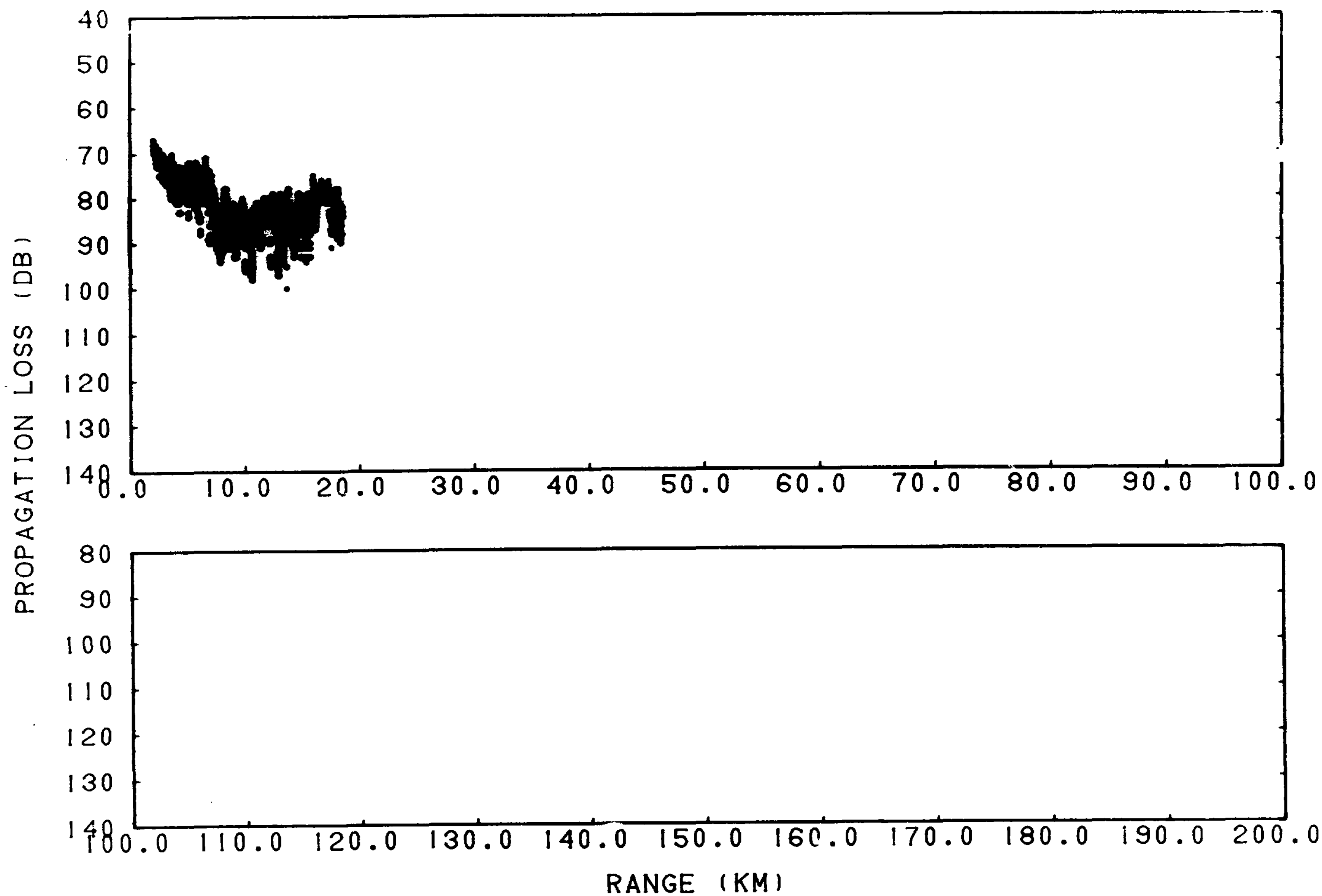
(C) Figure IIH-18. Gulf of Alaska, Run 112B, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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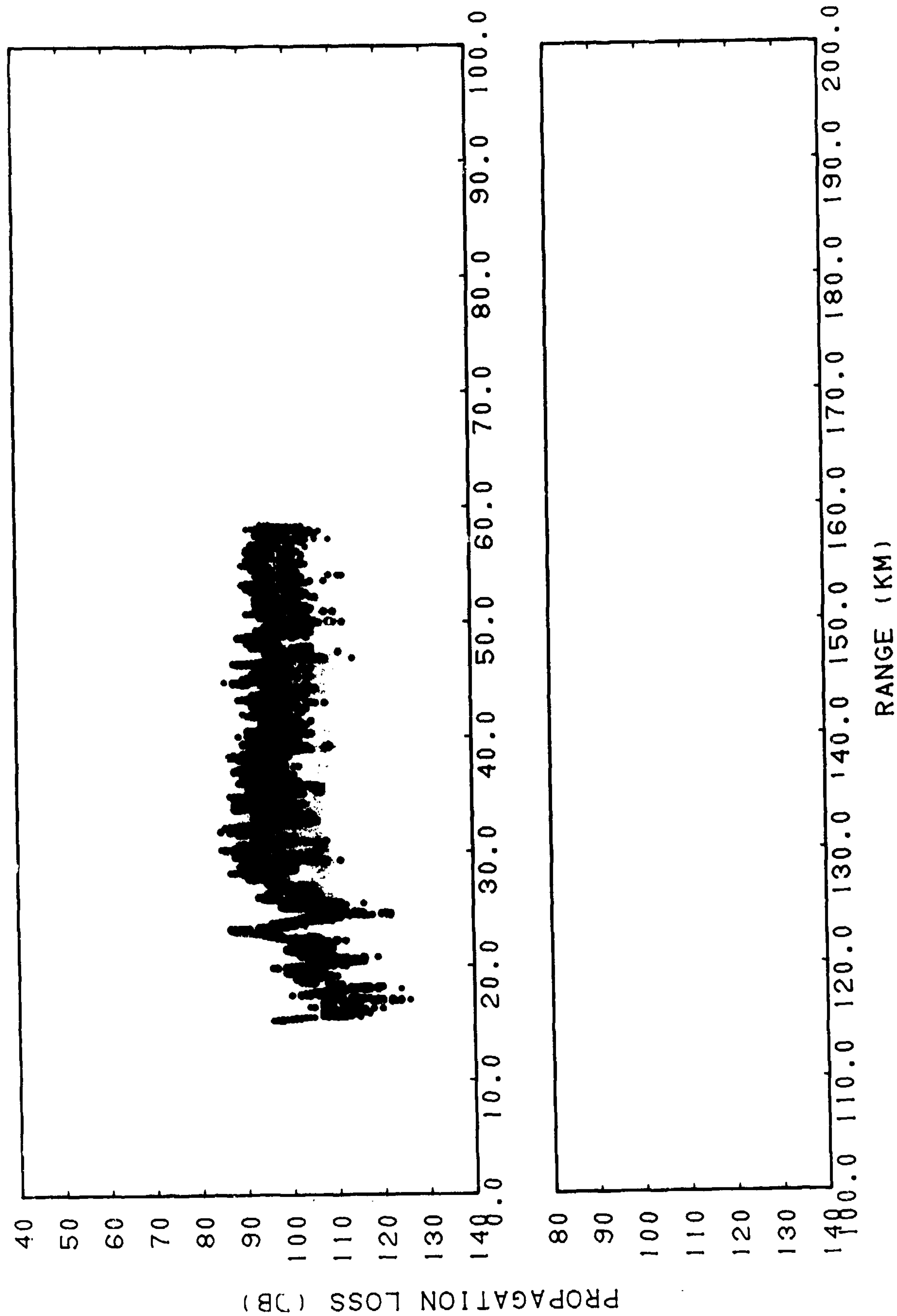
(C) Figure IIH-19. Gulf of Alaska, Run 112B, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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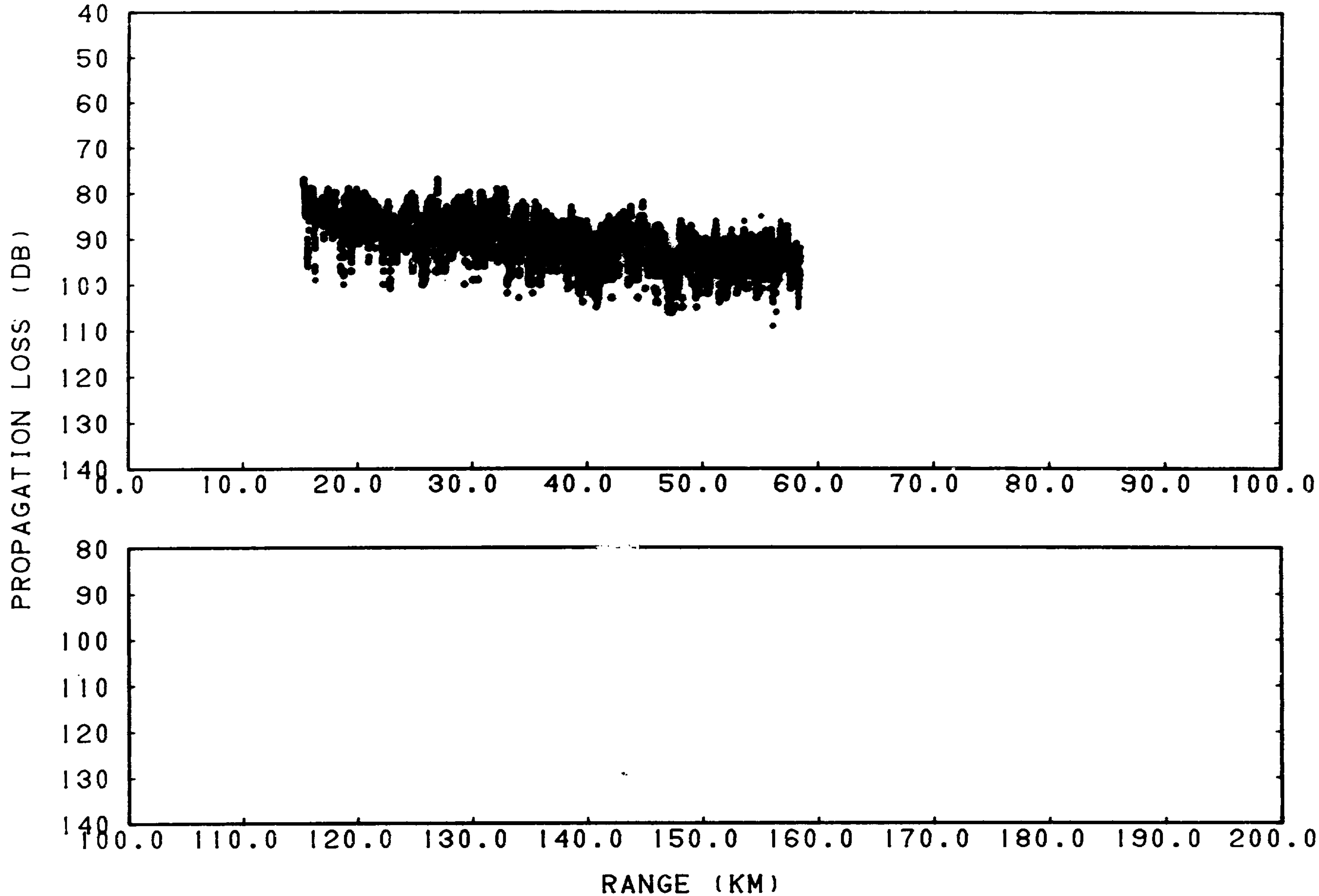
(C) Figure IIH-20. Gulf of Alaska, Run 112A, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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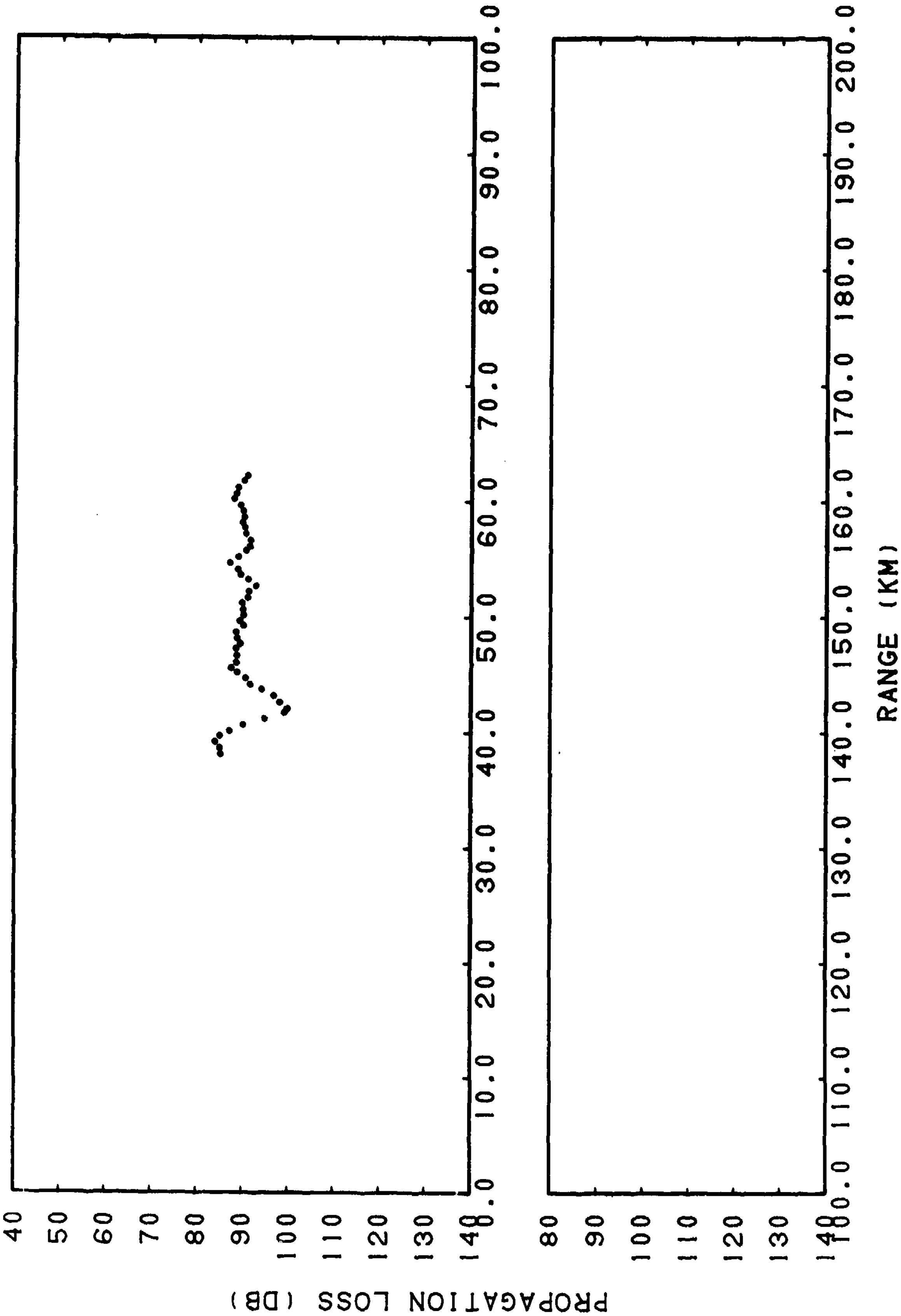
(C) Figure IIH-21. Gulf of Alaska, Run 112A, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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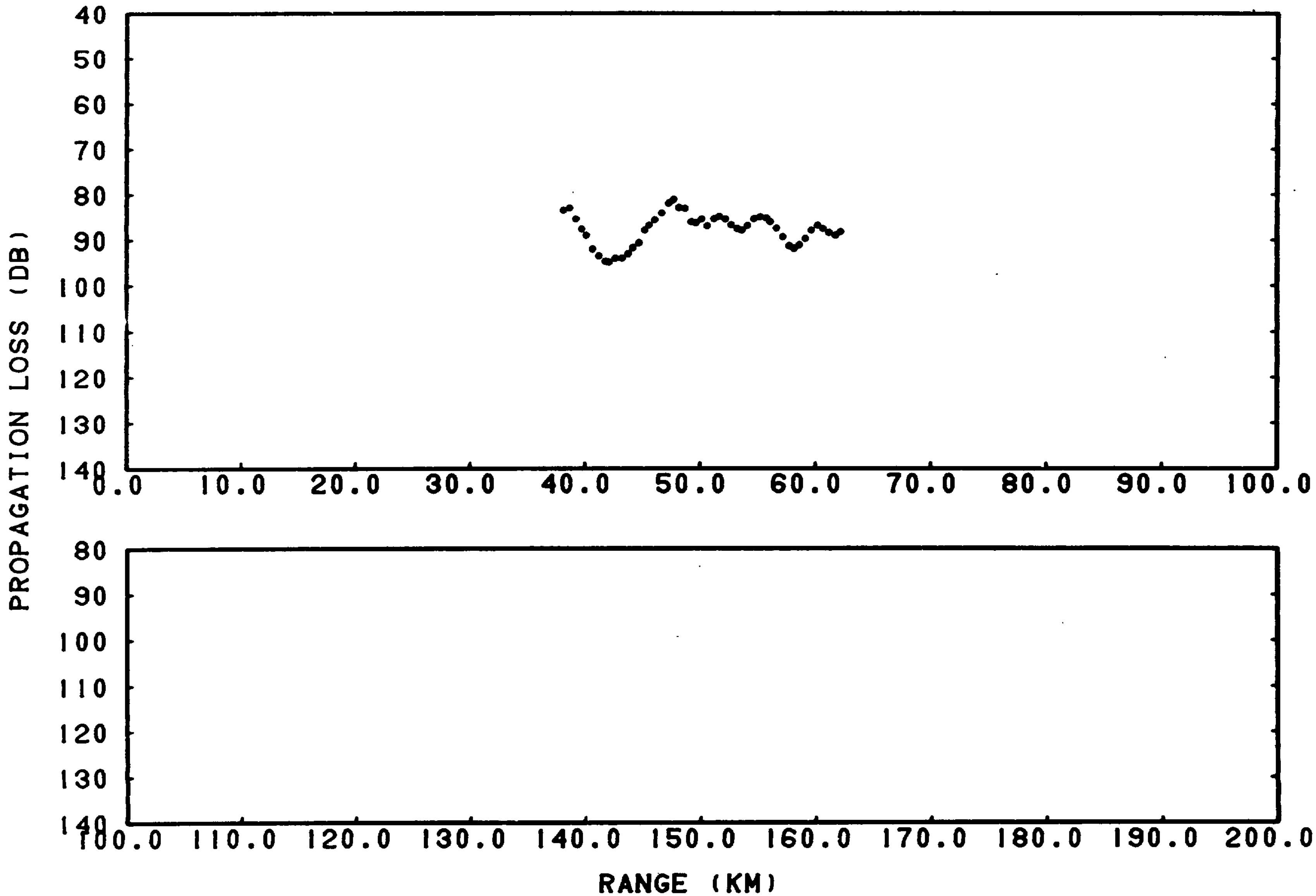
(C) Figure IIH-22. Smoothed Gulf of Alaska, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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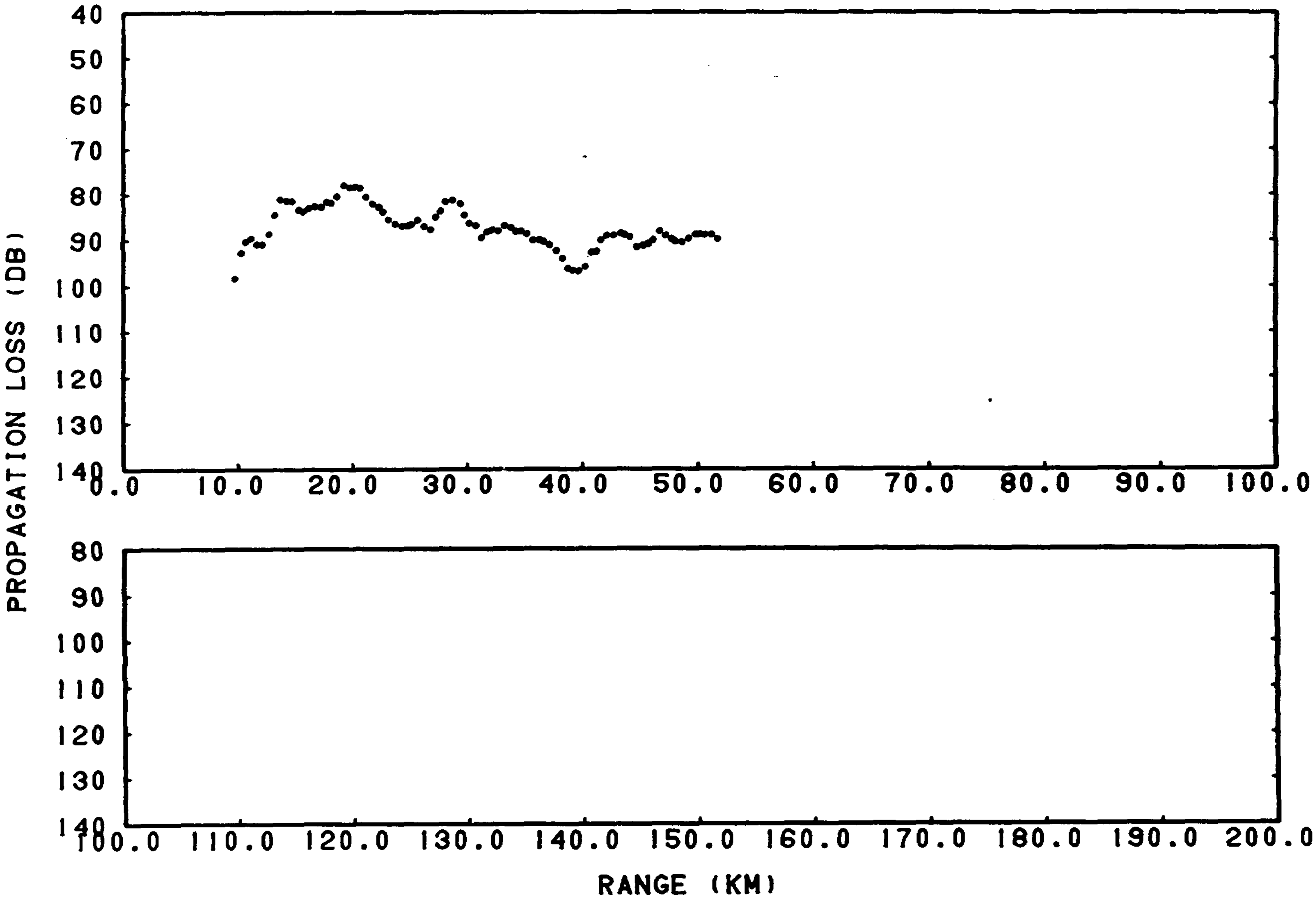
(C) Figure IIH-23. Smoothed Gulf of Alaska, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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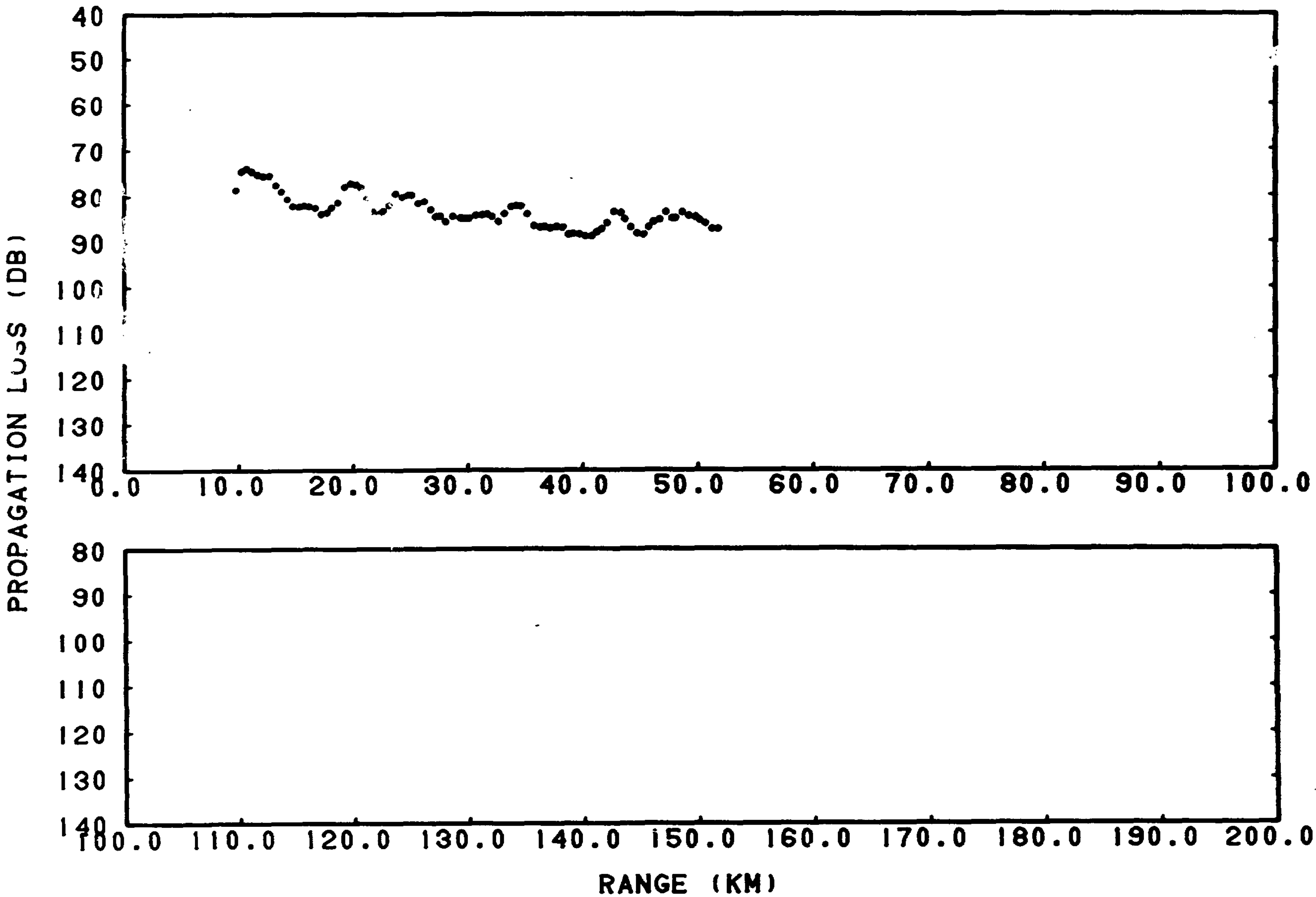
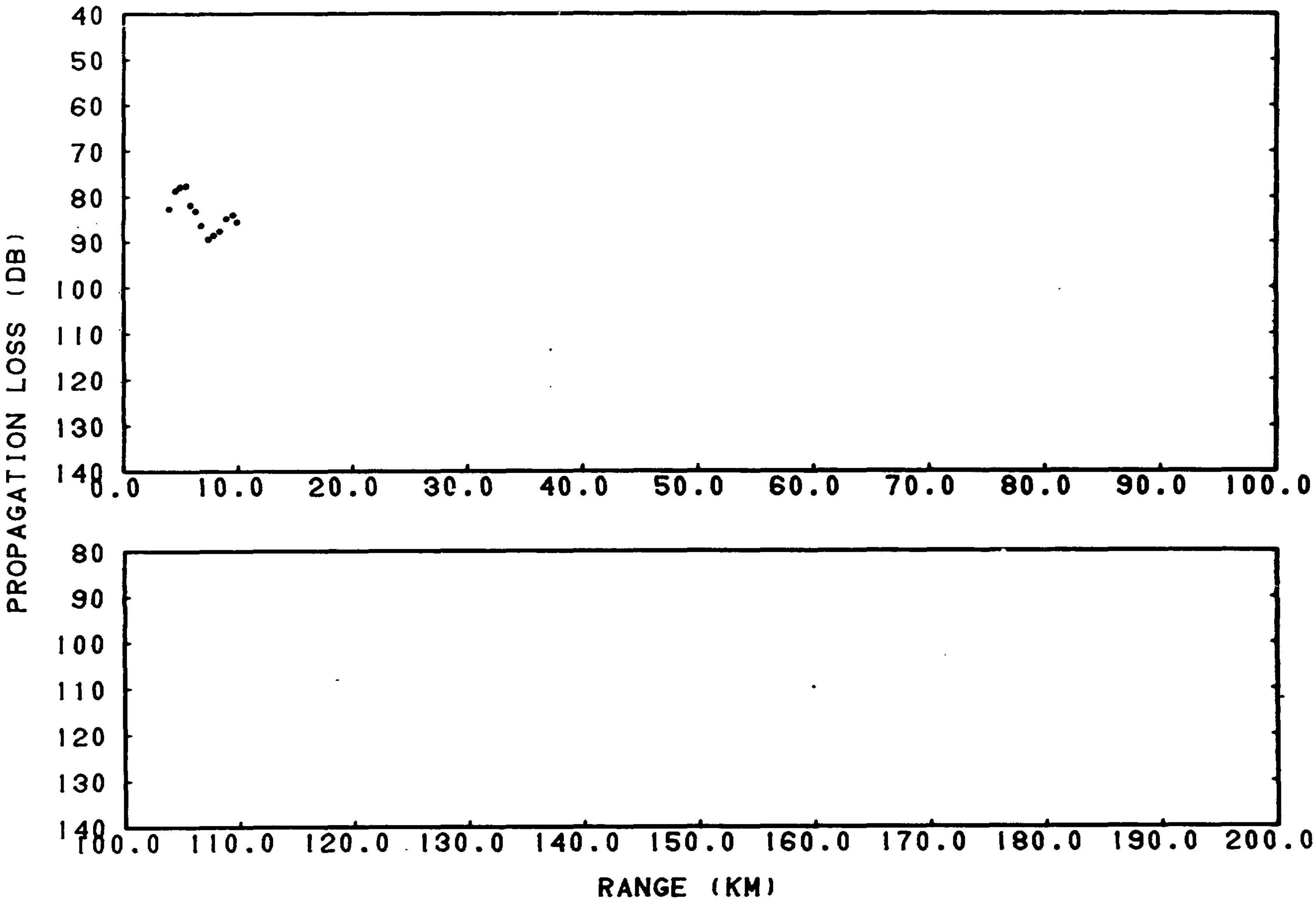
(C) Figure IIH-24. Smoothed Gulf of Alaska, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



CONFIDENTIAL

(C) Figure IIH-25. Smoothed Gulf of Alaska, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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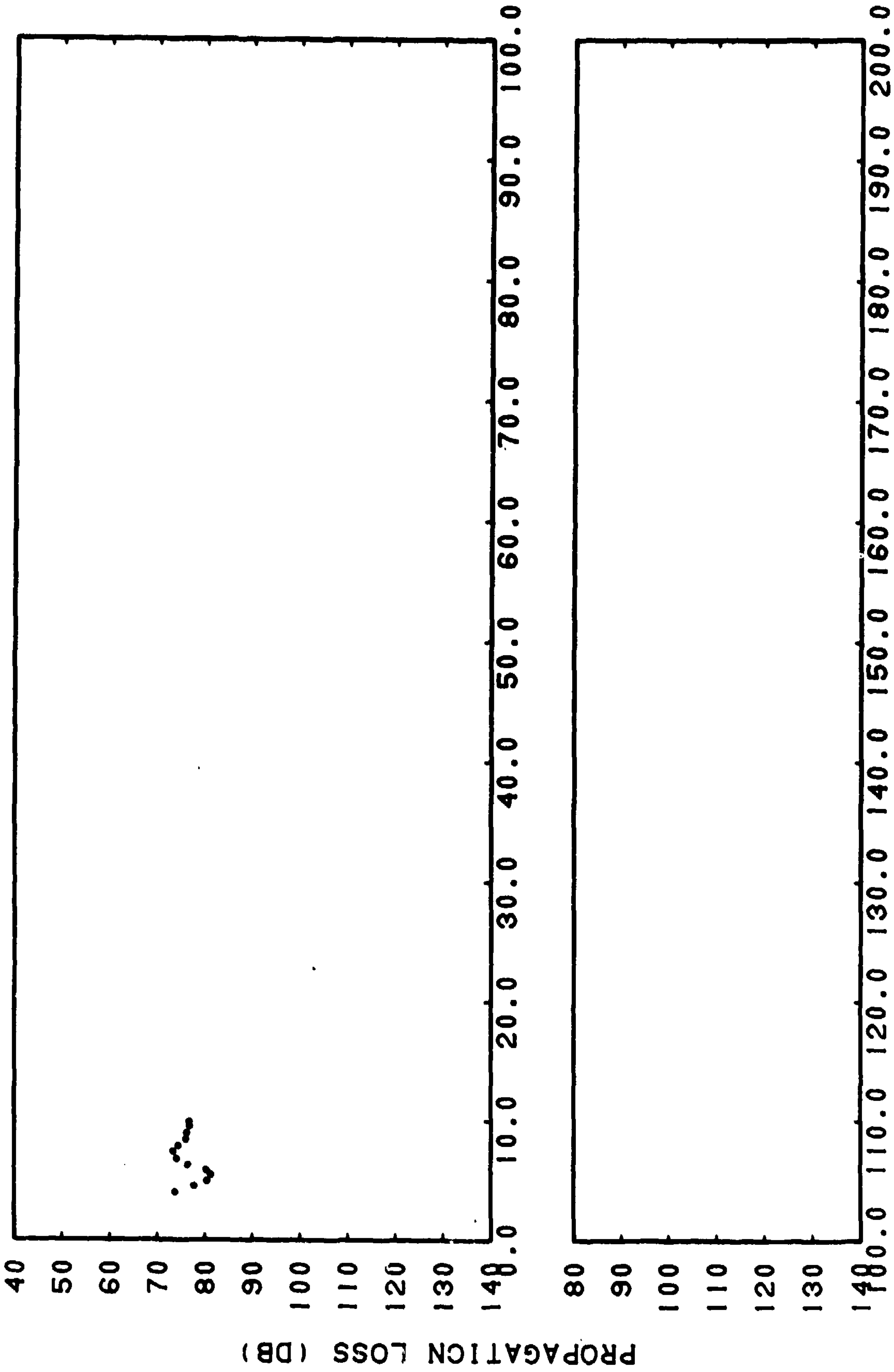
(C) Figure IIH-26. Smoothed Gulf of Alaska, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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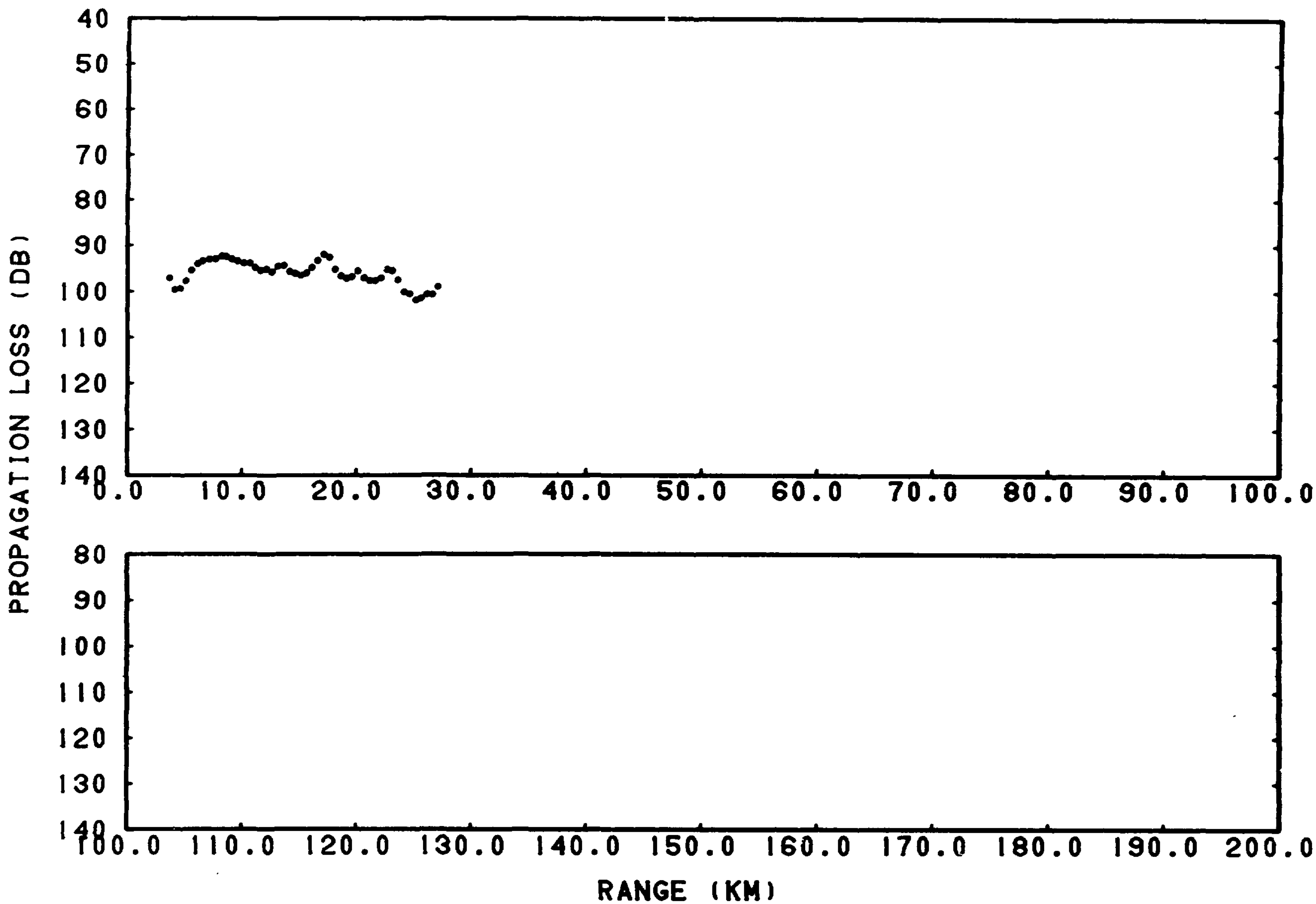
(C) Figure IIH-27. Smoothed Gulf of Alaska, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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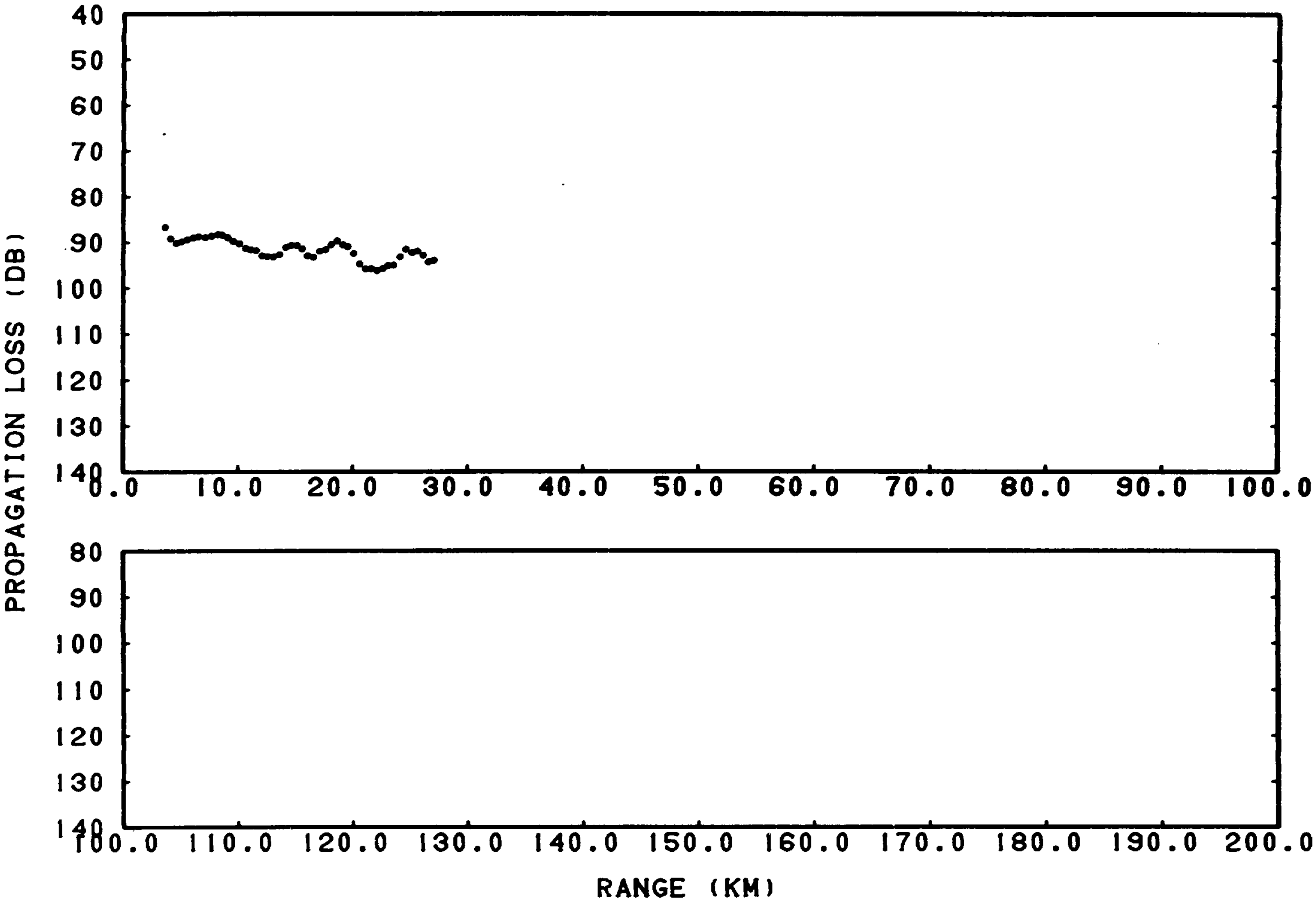
(C) Figure IIH-28. Smoothed Gulf of Alaska, Run 108, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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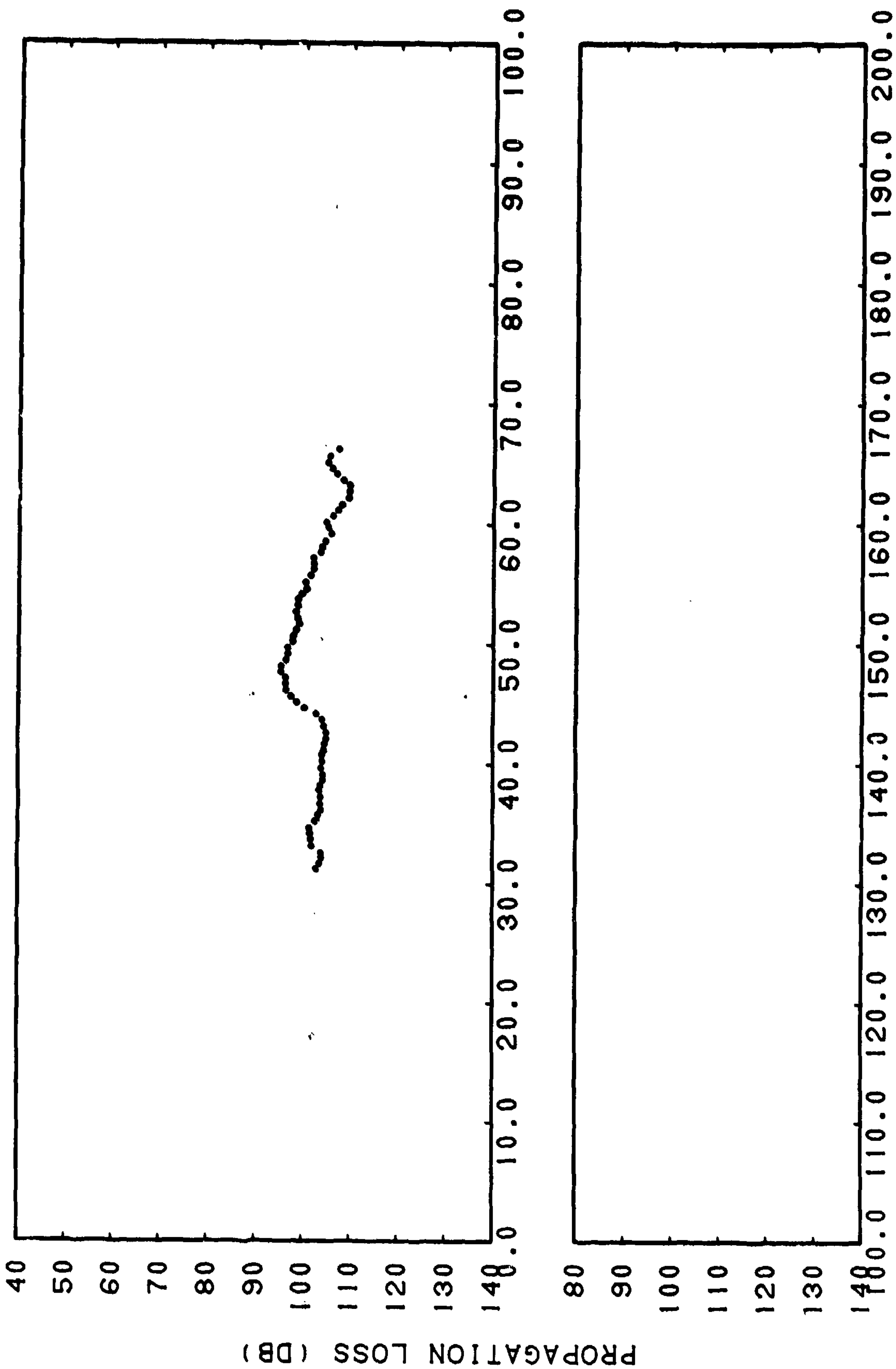
(C) Figure IIH-29. Smoothed Gulf of Alaska, Run 108, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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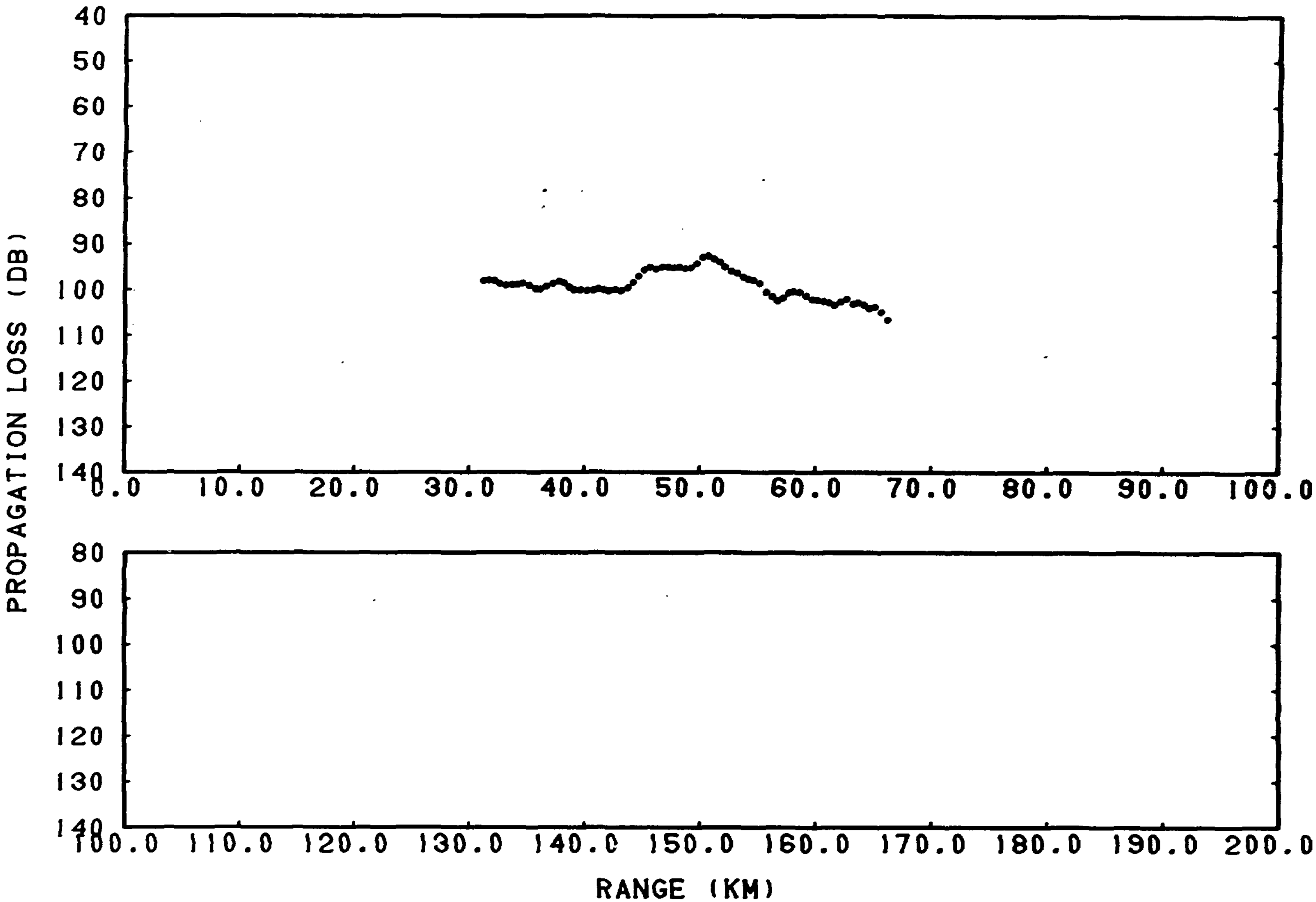
(C) Figure IIH-30. Smoothed Gulf of Alaska, Run 107, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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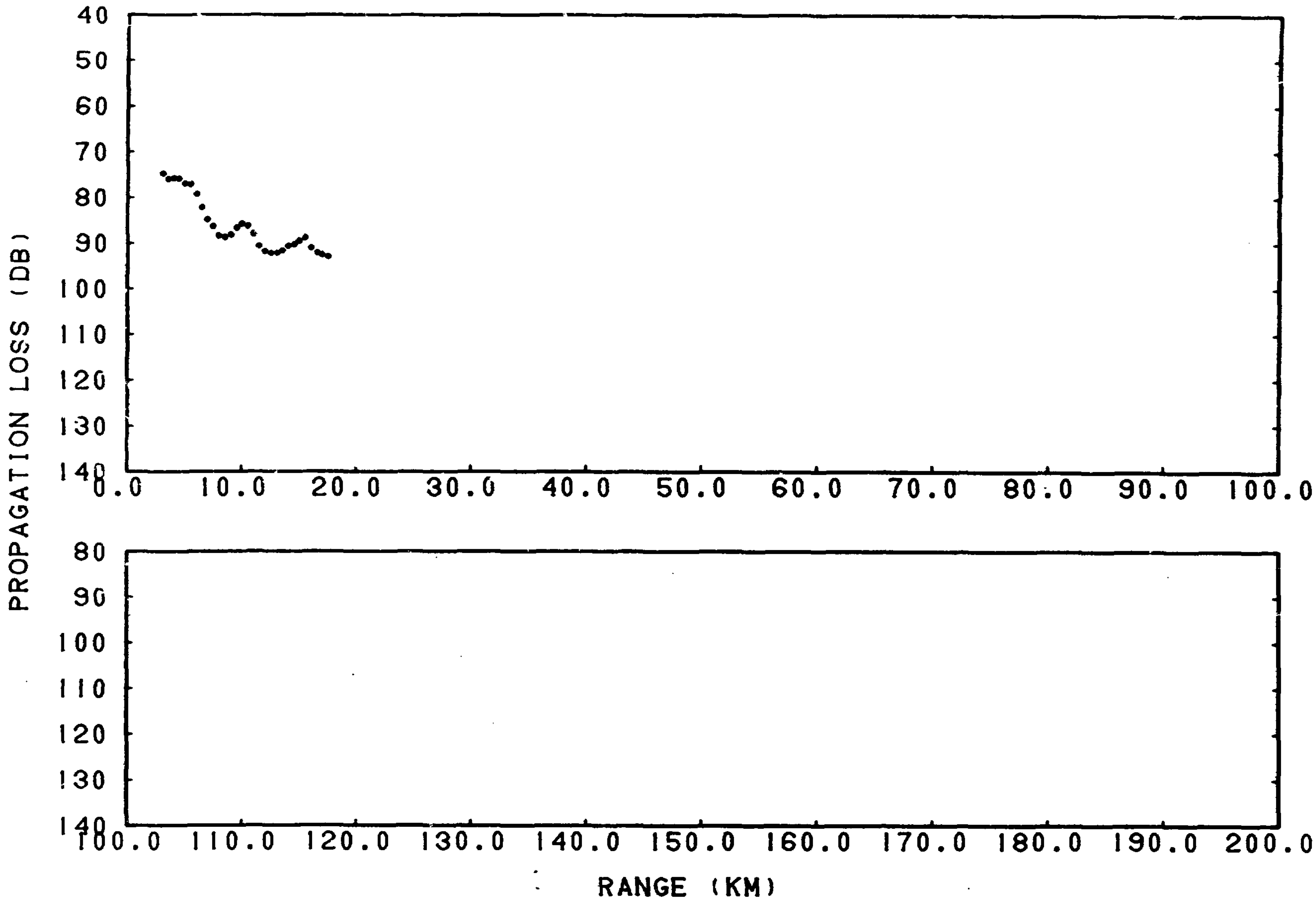
(C) Figure IIH-31. Smoothed Gulf of Alaska, Run 107, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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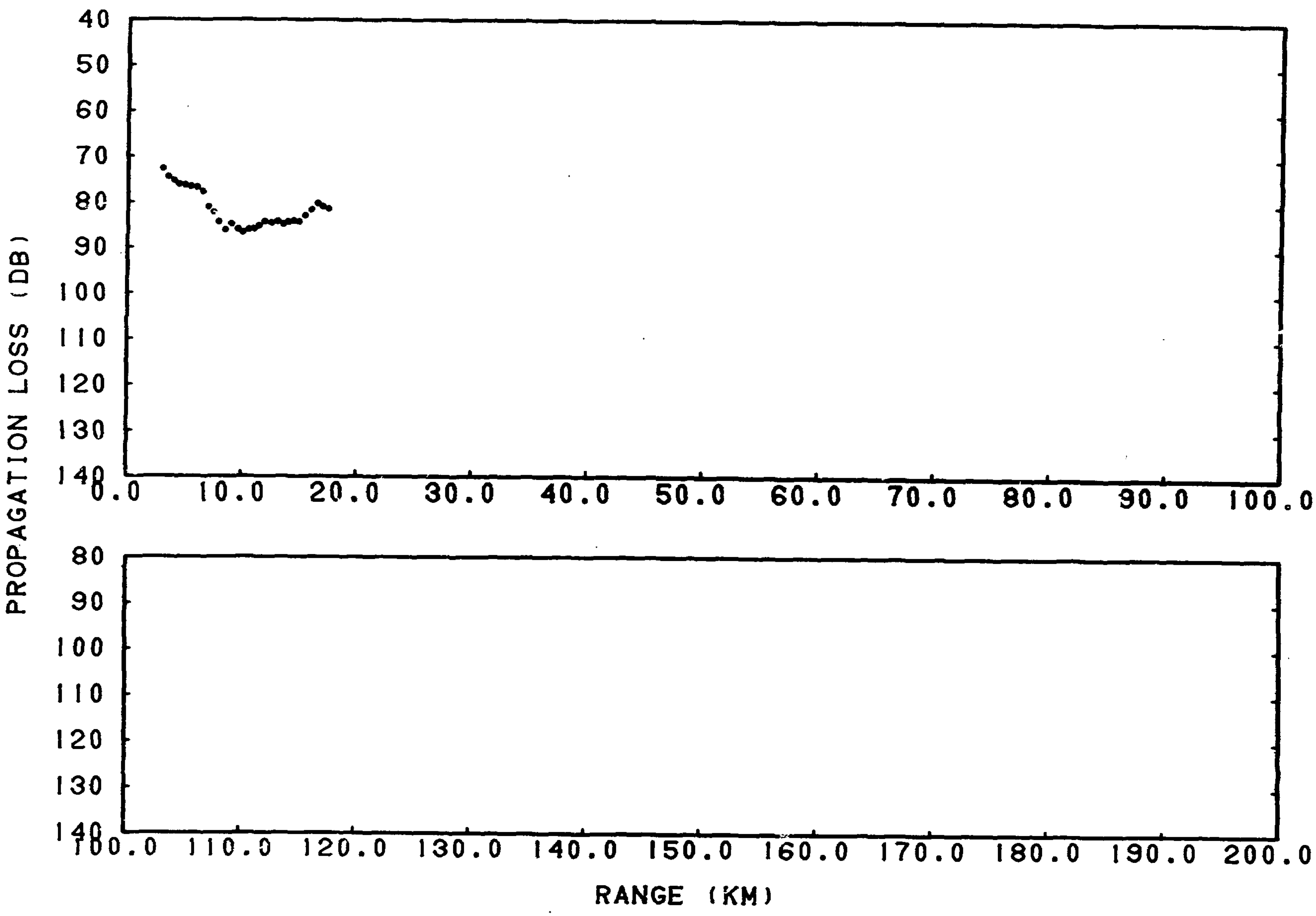
(C) Figure IIH-32. Smoothed Gulf of Alaska, Run 112B, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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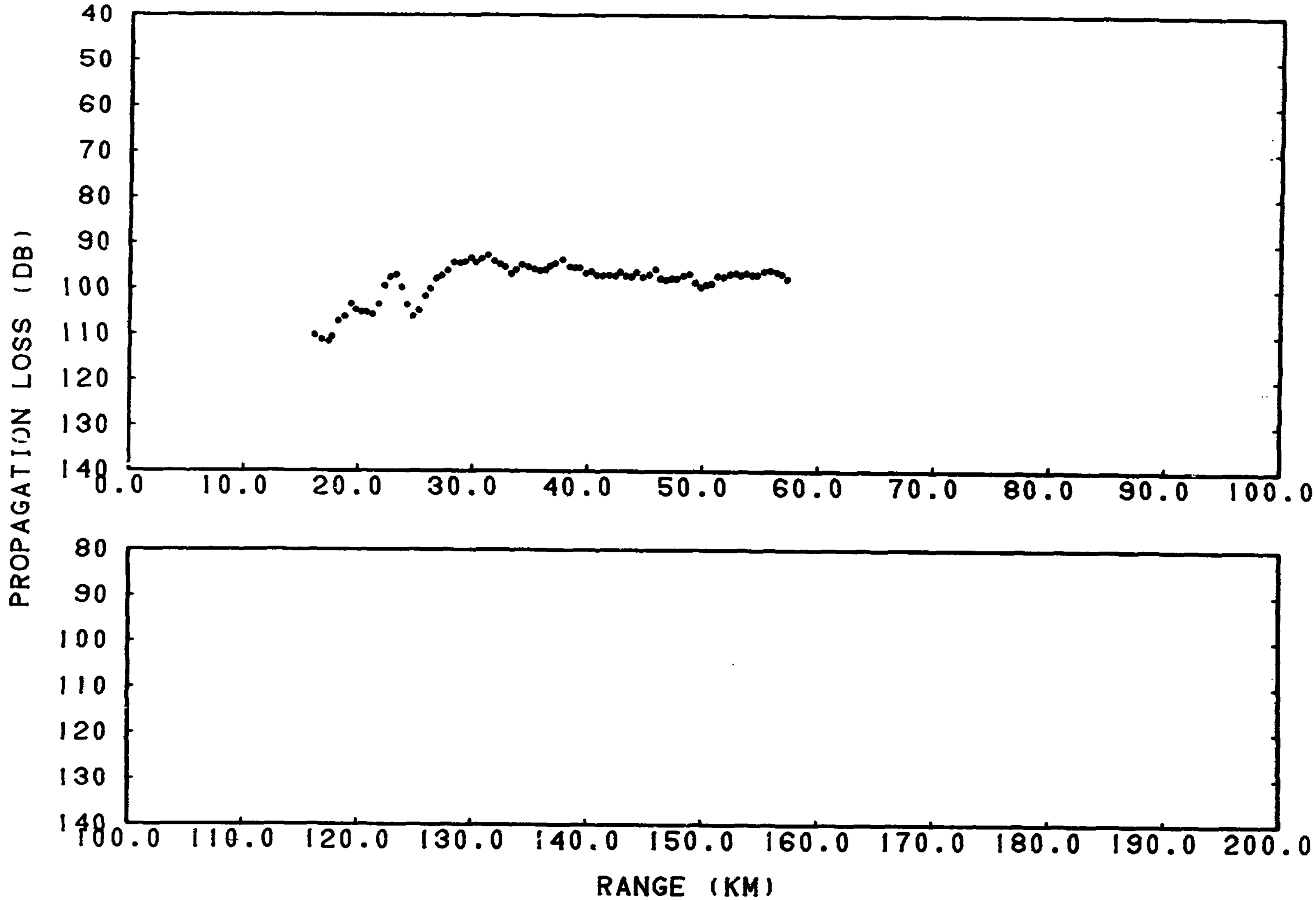
(C) Figure IIH-33. Smoothed Gulf of Alaska, Run 112B, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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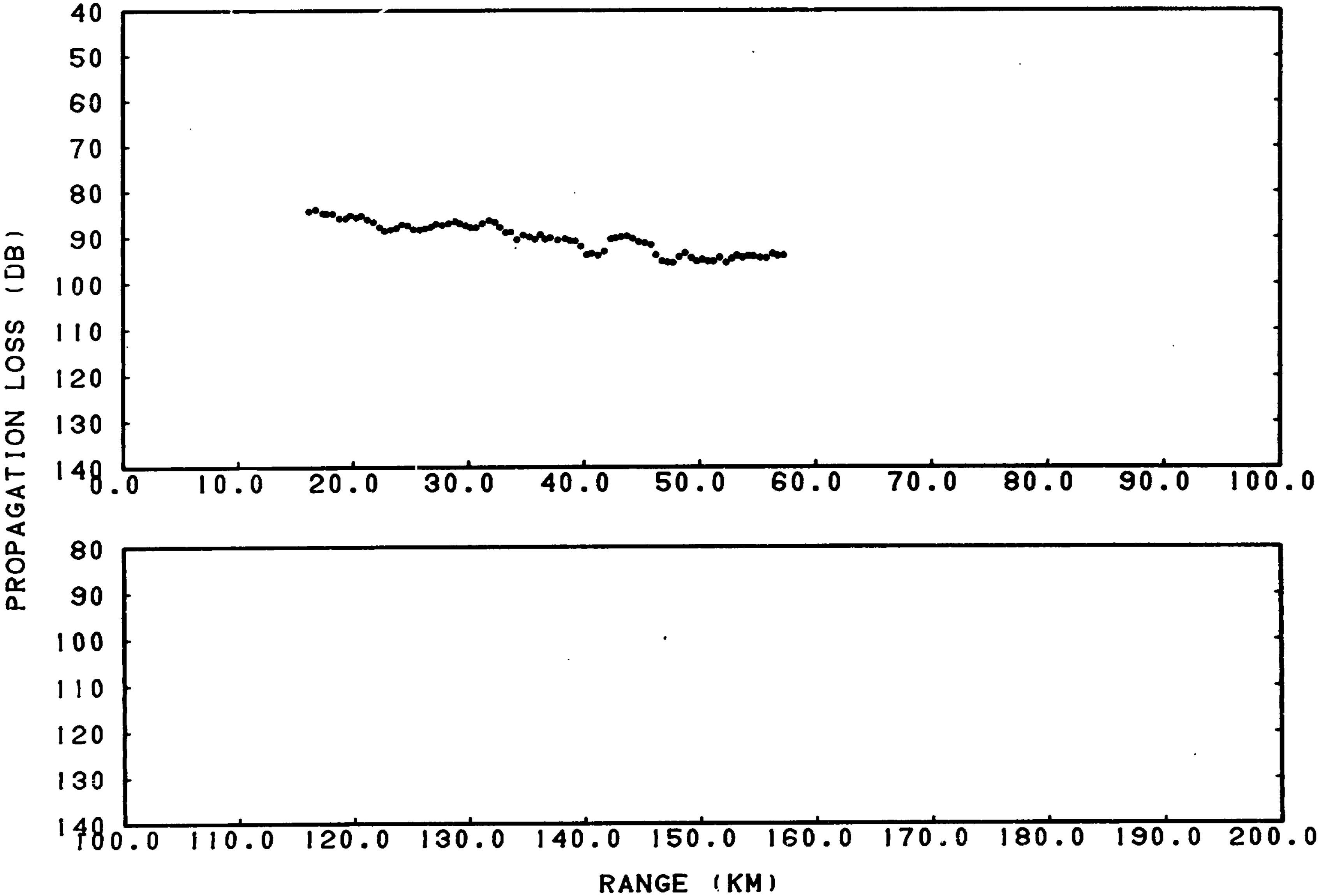
(C) Figure IIH-34. Smoothed Gulf of Alaska, Run 112A, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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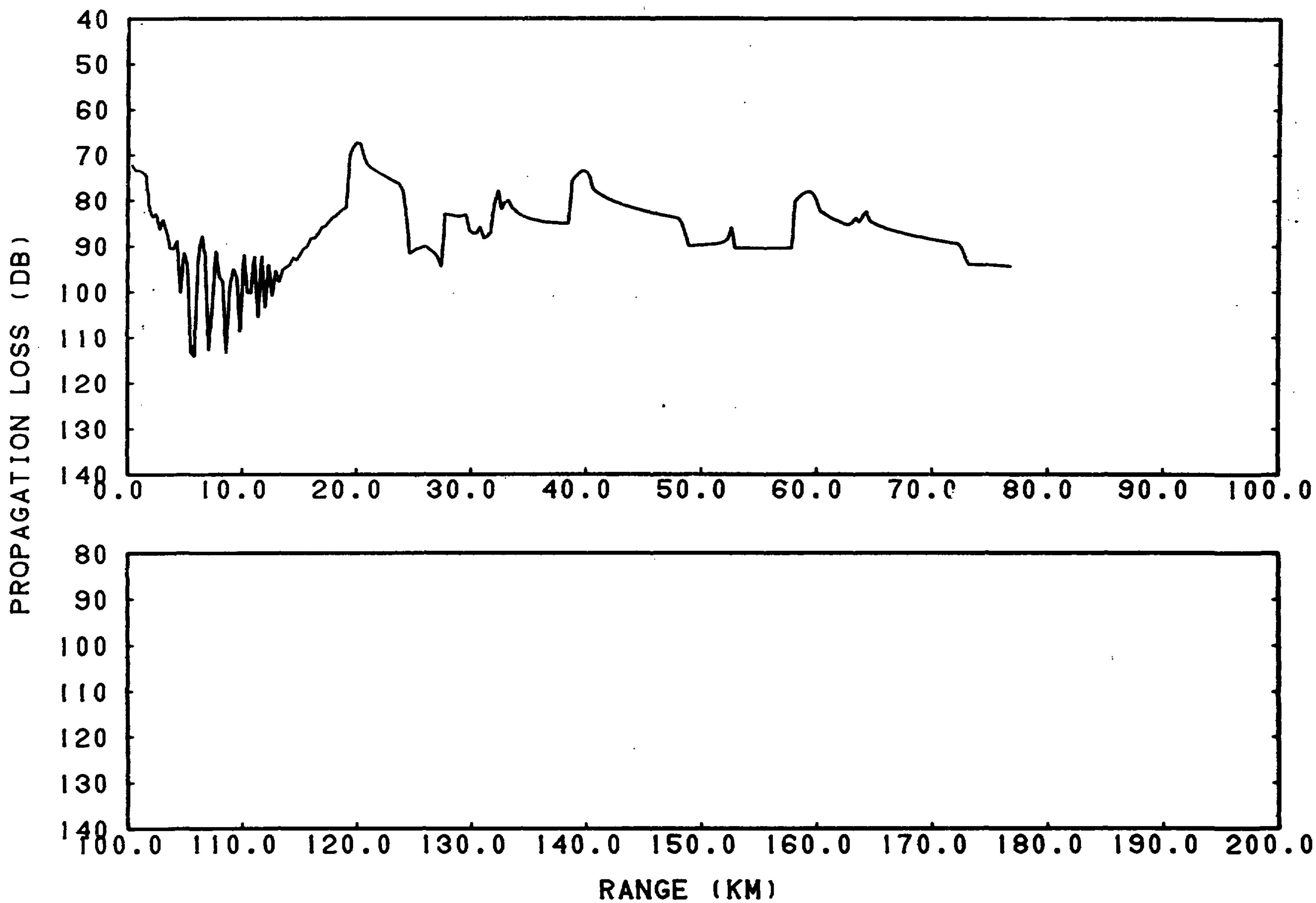
(C) Figure IIH-35. Smoothed Gulf of Alaska, Run 112A, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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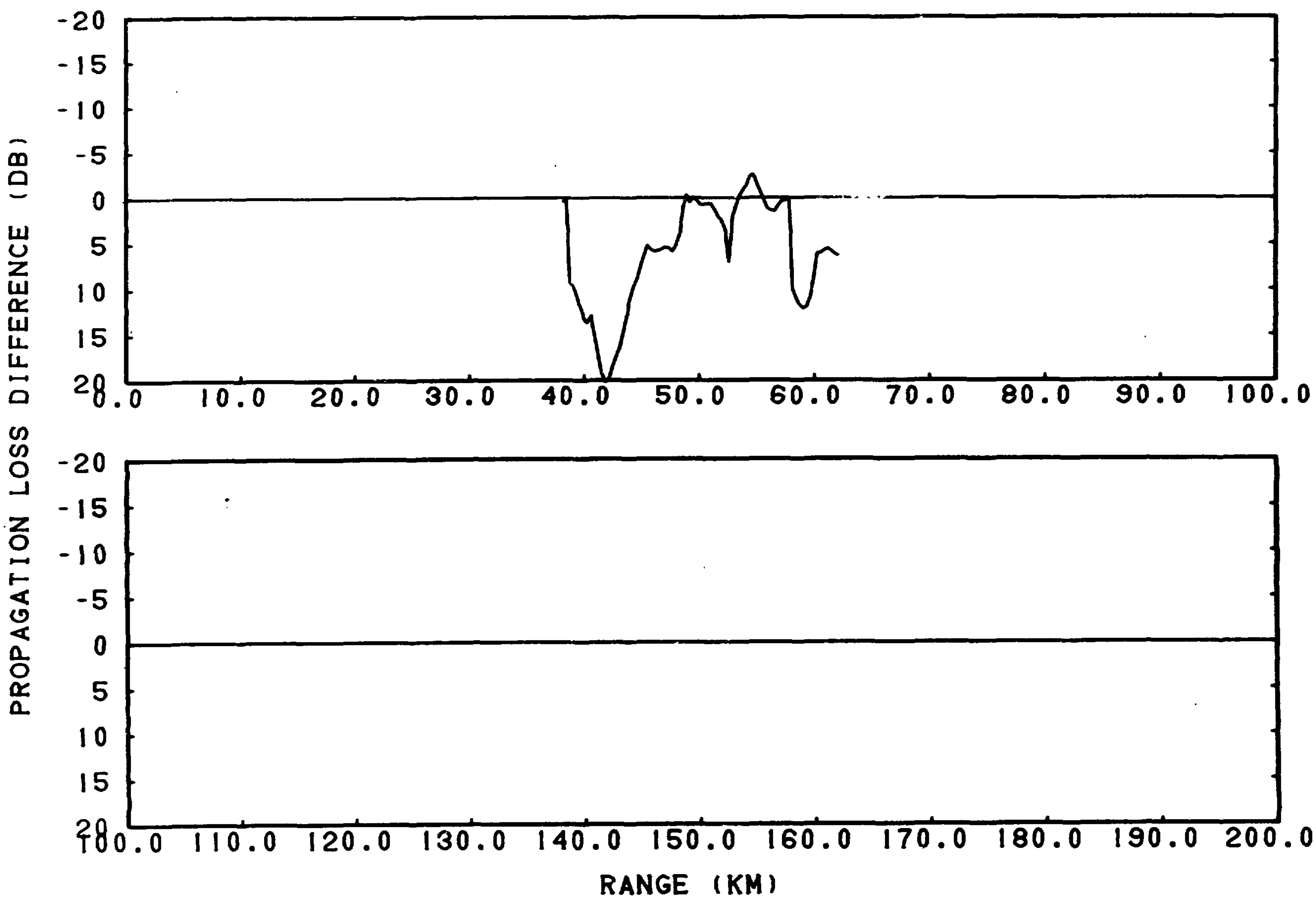
(C) Figure IIH-36. FACT Coherent, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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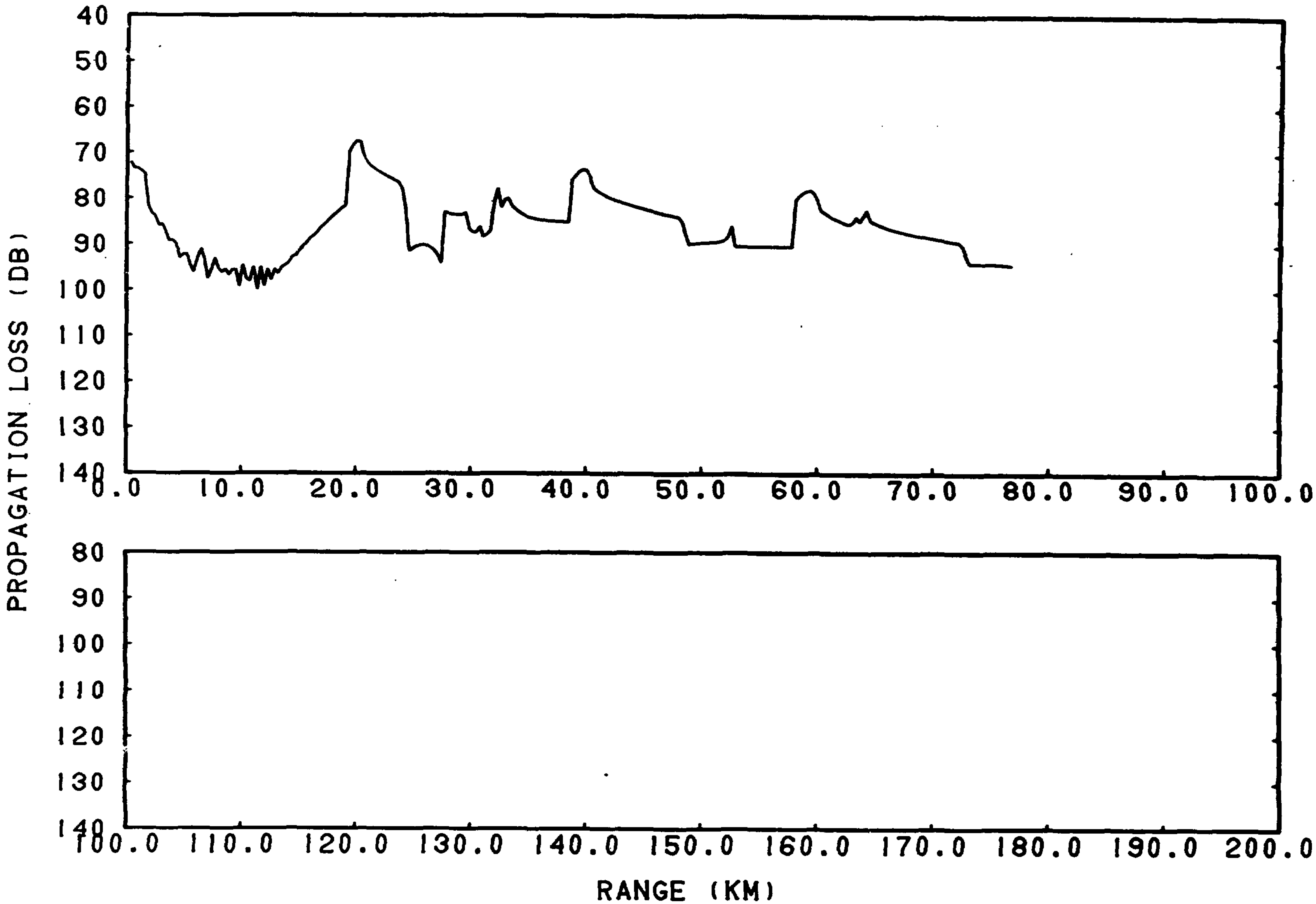
(C) Figure IIH-37. FACT Coherent, Run 140, Source Depth = 30.5 Meters Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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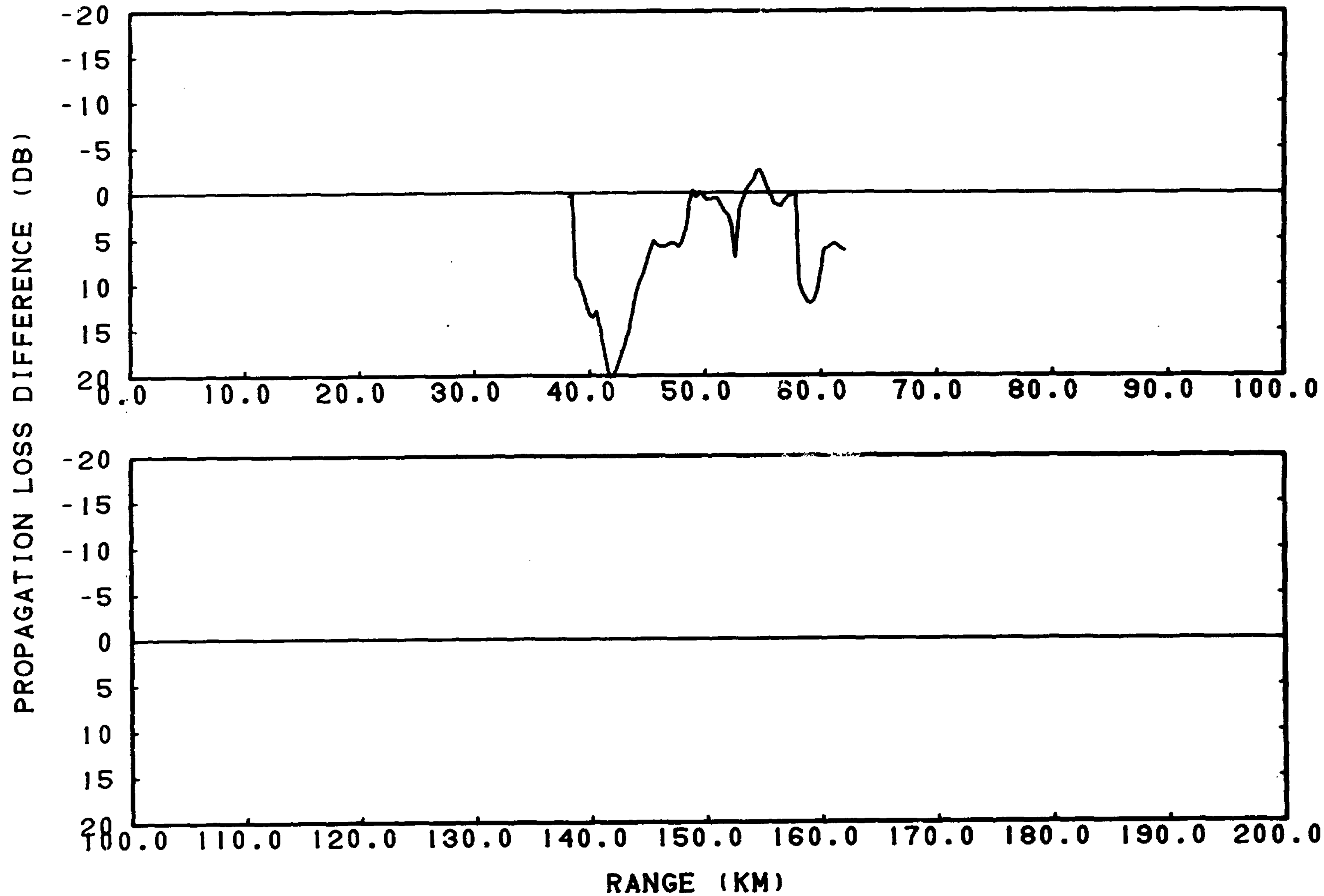
(C) Figure IIH-38. FACT Semi-coherent, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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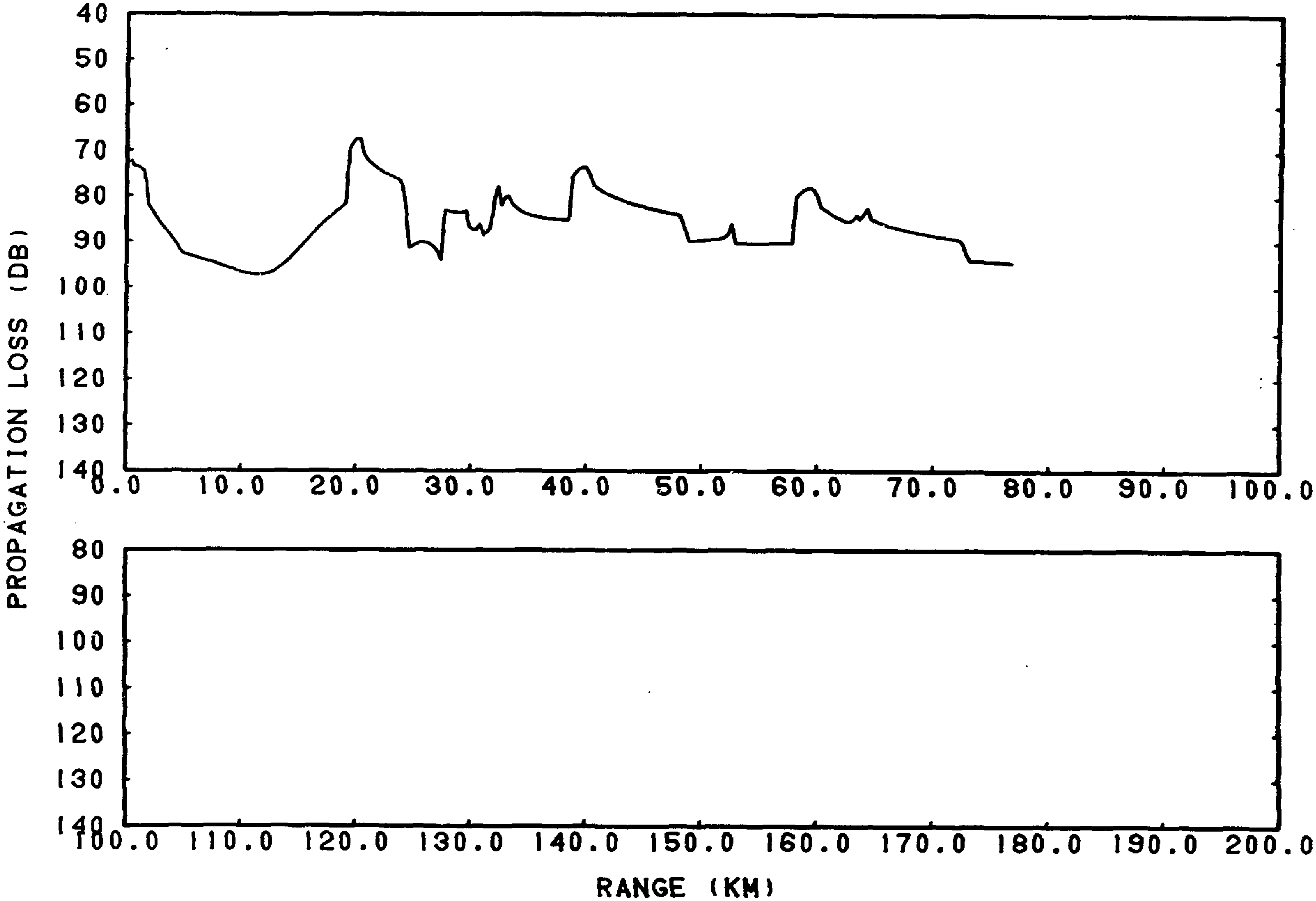
(C) Figure IIH-39. FACT Semi-coherent, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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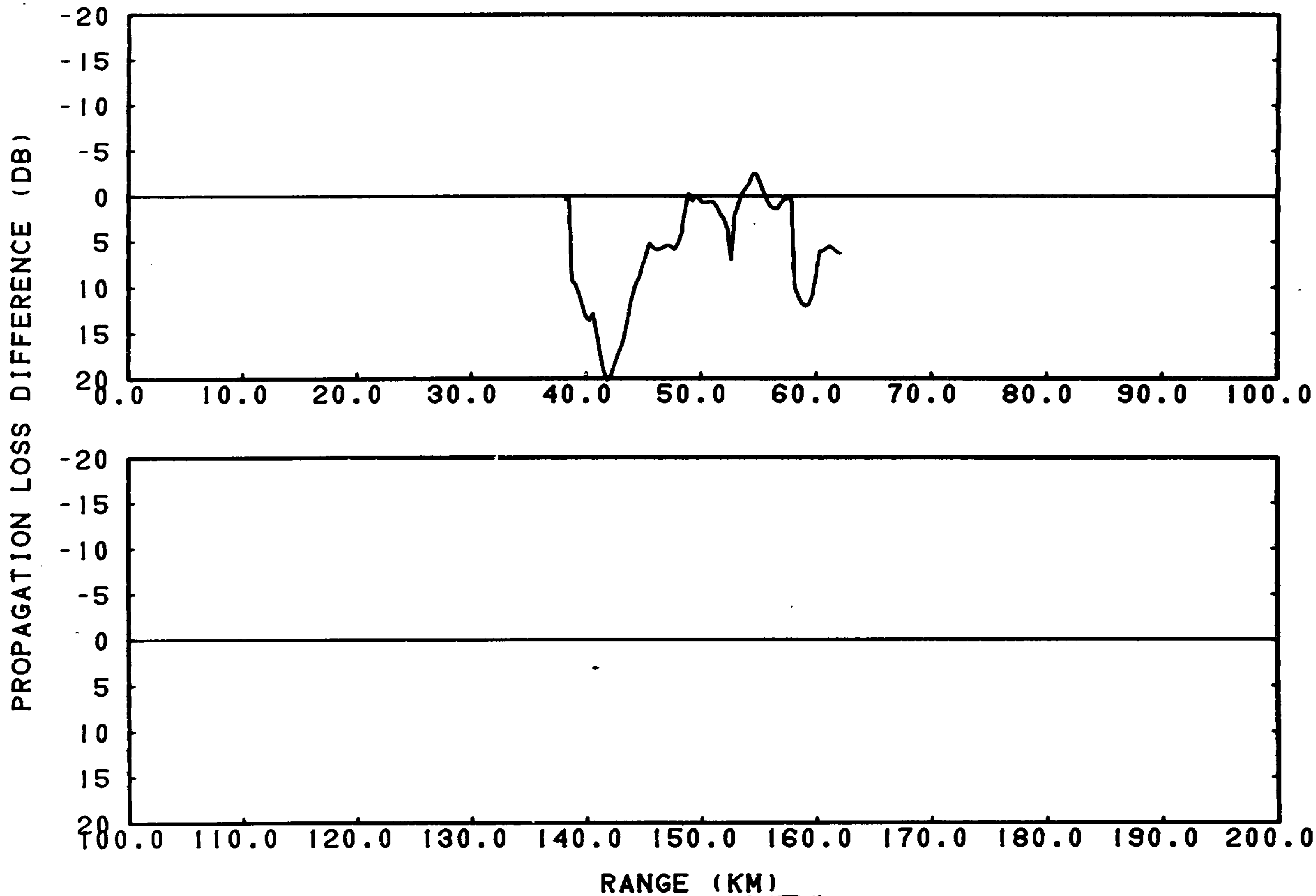
(C) Figure IIH-40. FACT Incoherent, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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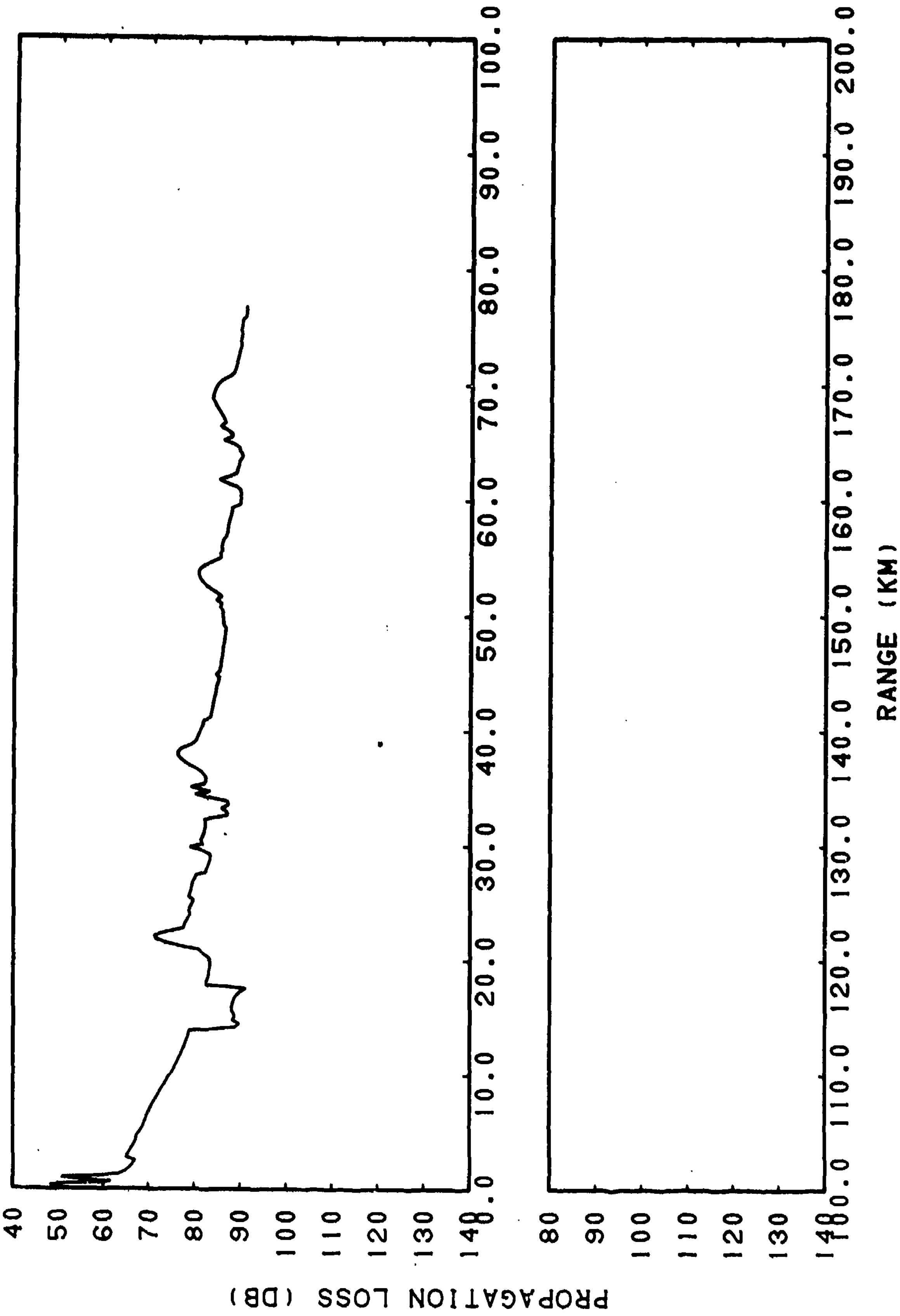
(C) Figure IIH-41. FACT Incoherent, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Receiver Depth = 1.5 Kilohertz



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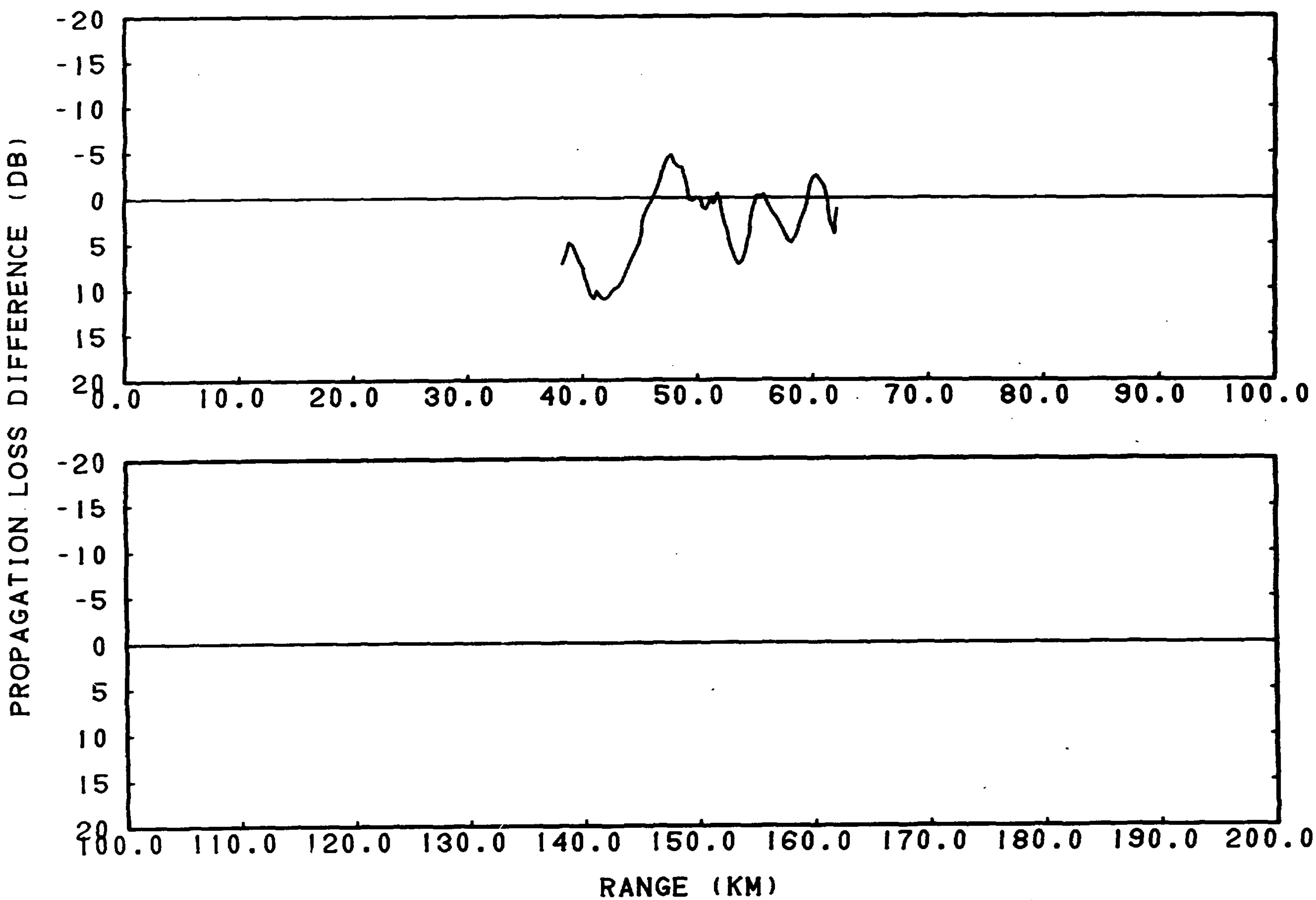
(C) Figure IIH-42. FACT Coherent, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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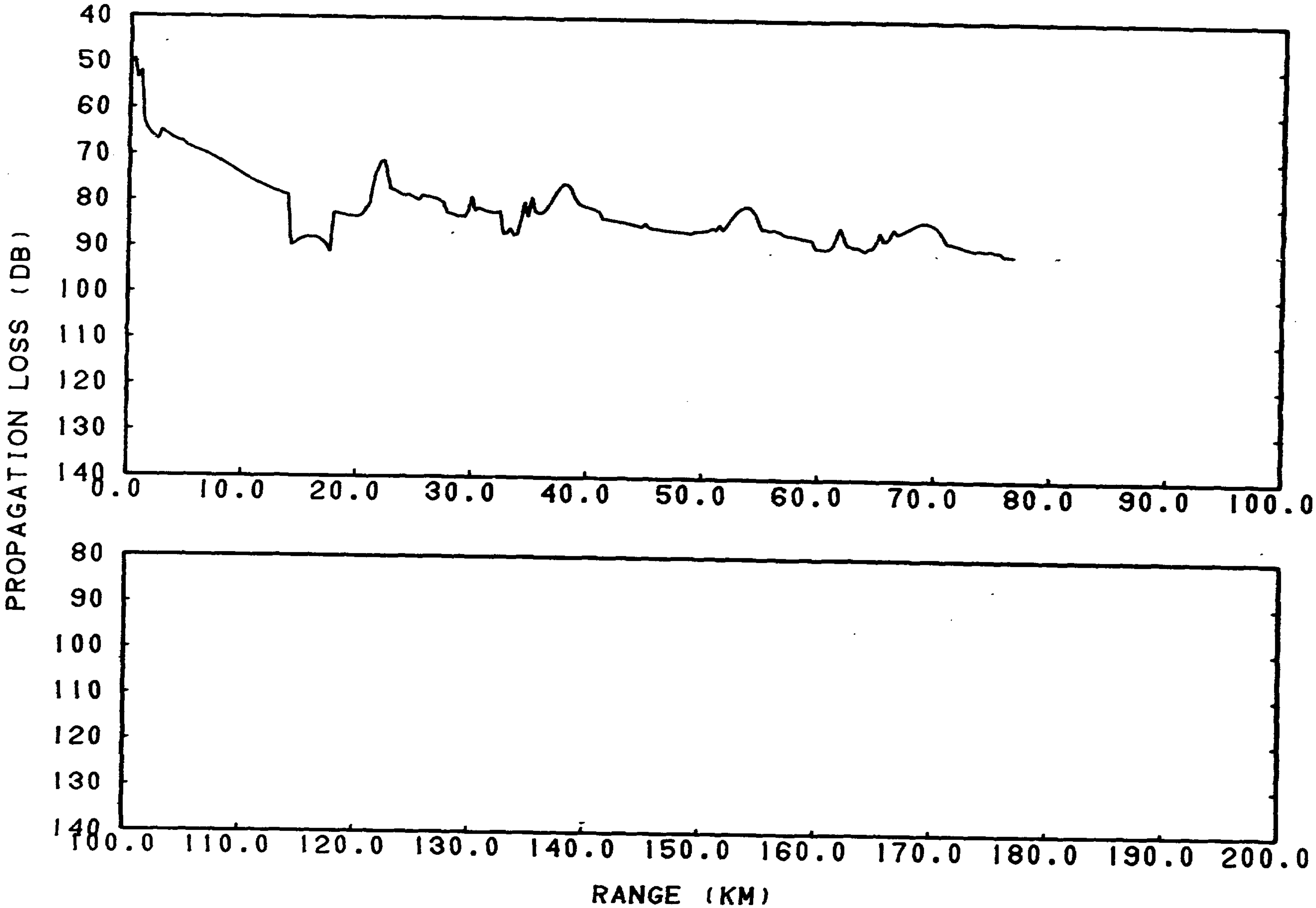
(C) Figure IIH-43. FACT Coherent, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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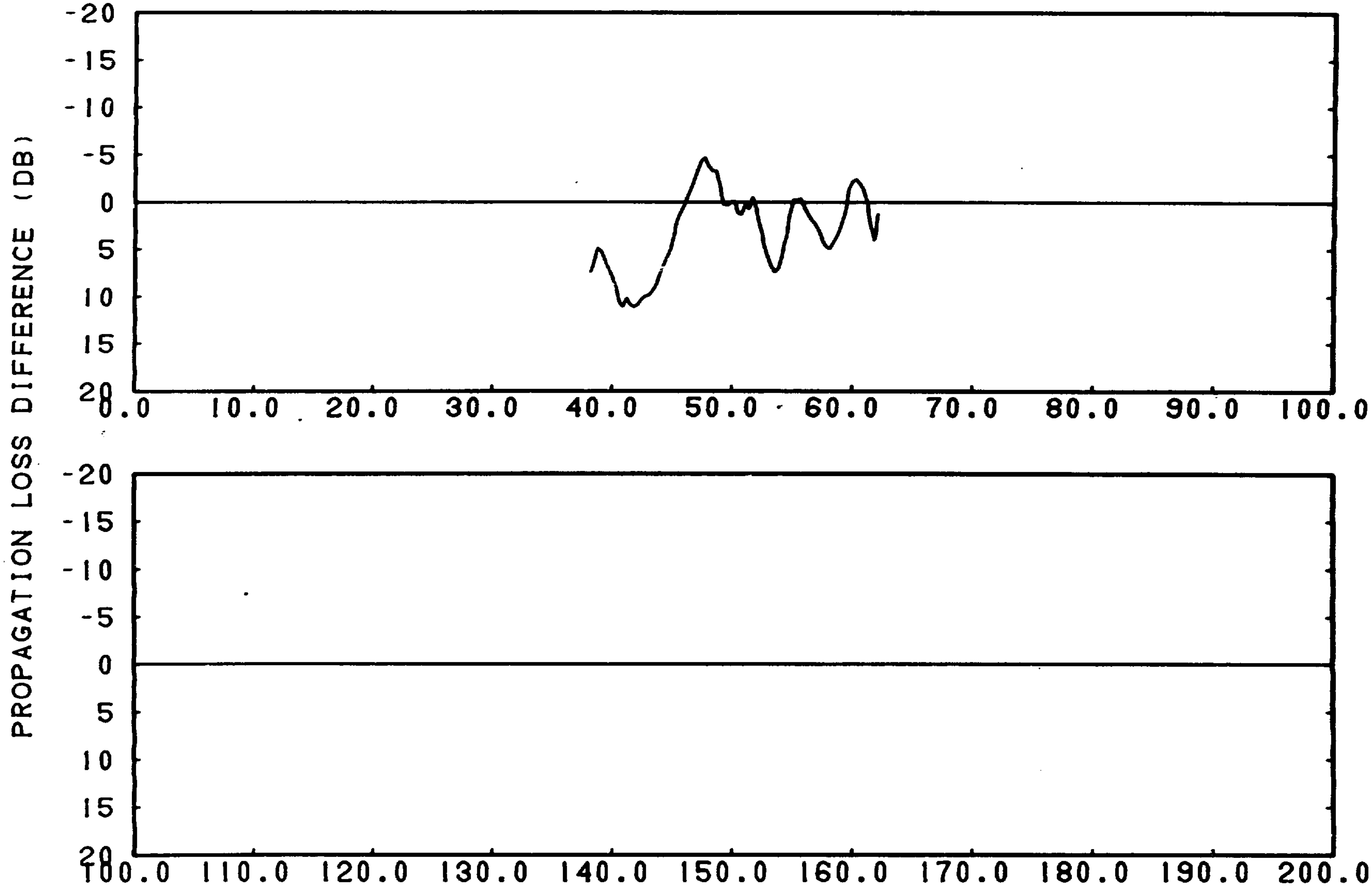
(C) Figure IIH-44. FACT Semi-coherent, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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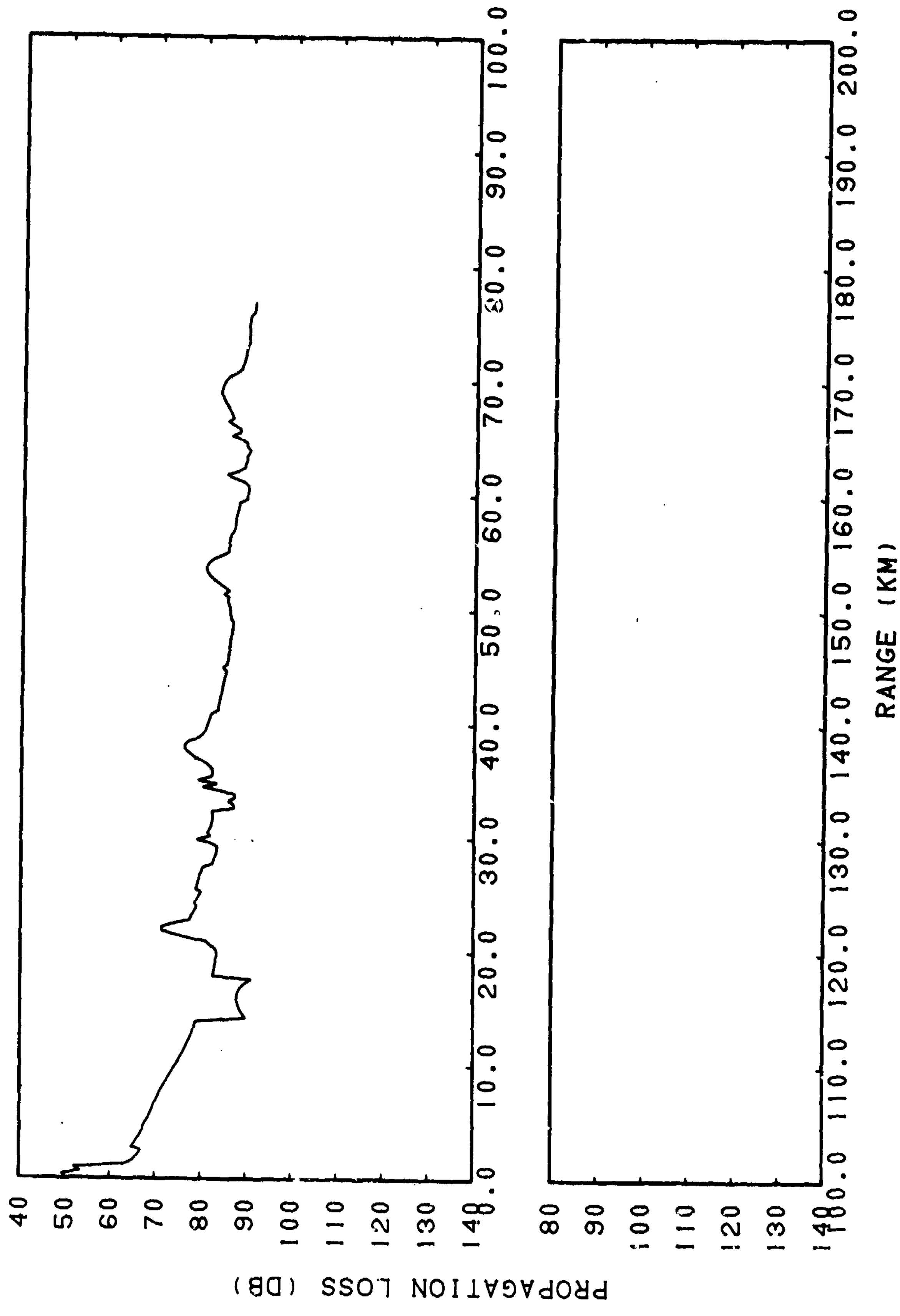
(C) Figure IIH-45. FACT Semi-coherent, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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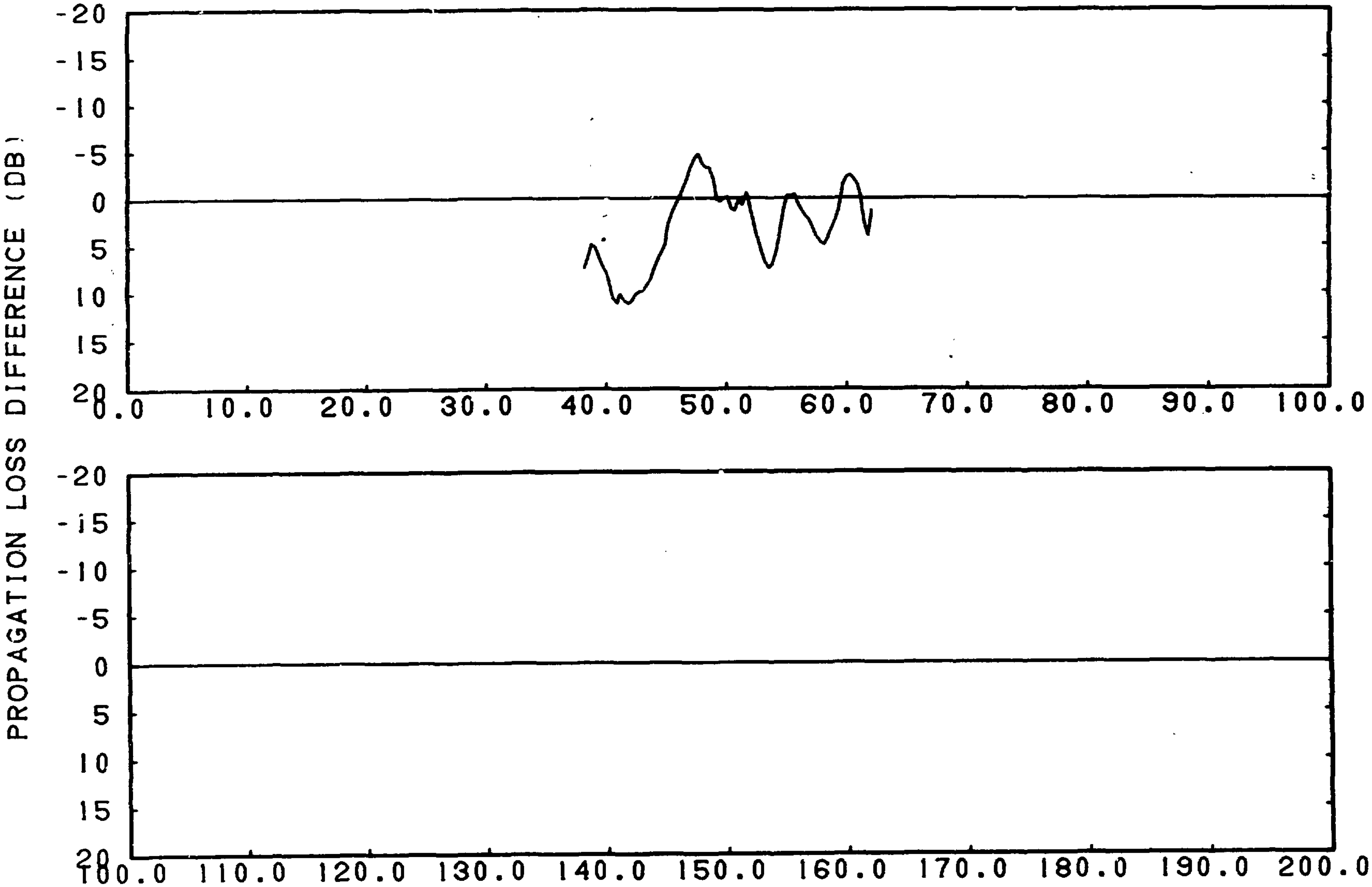
(C) Figure IIH-46. FACT Incoherent, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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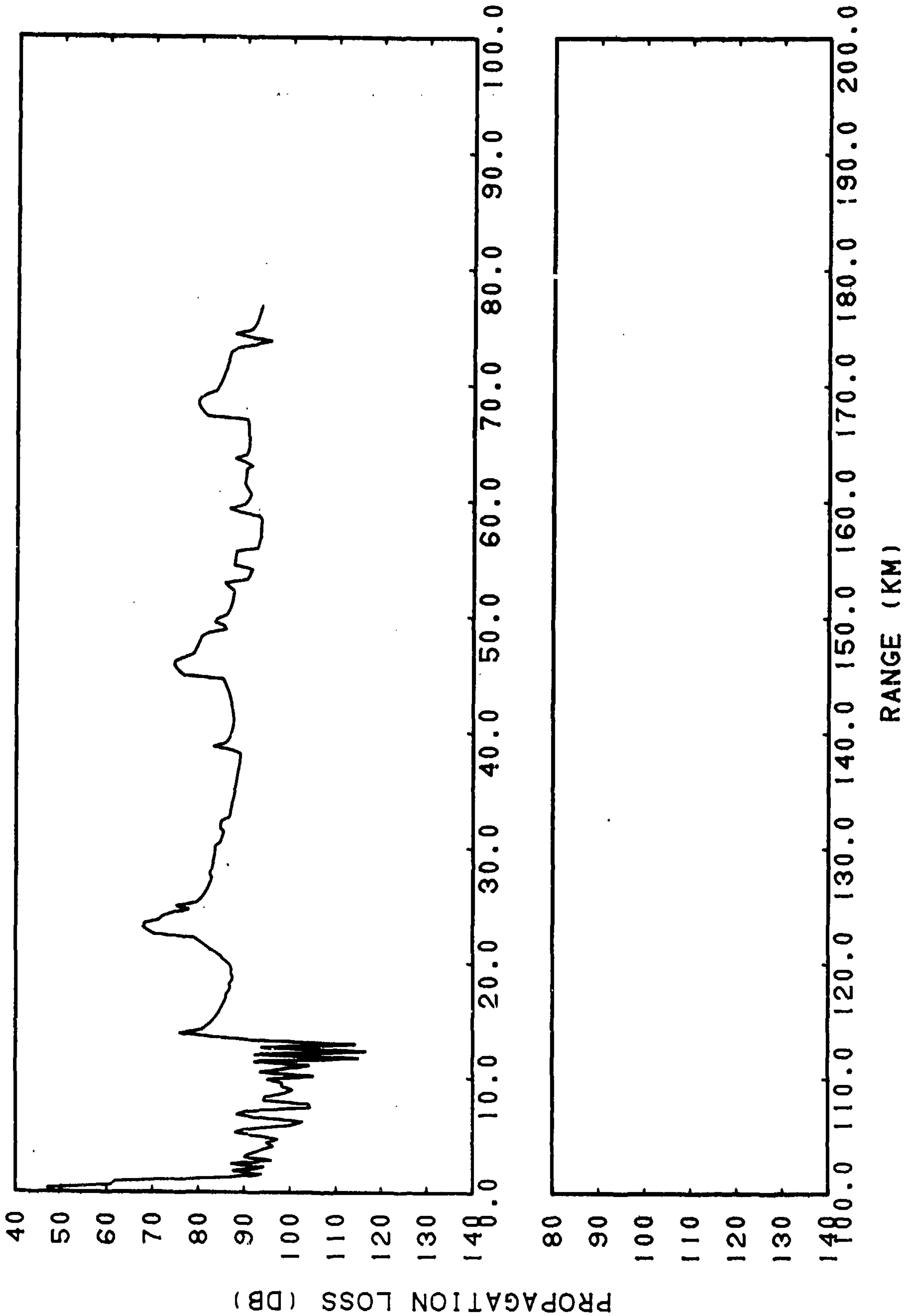
(C) Figure IIH-47. FACT Incoherent, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 140, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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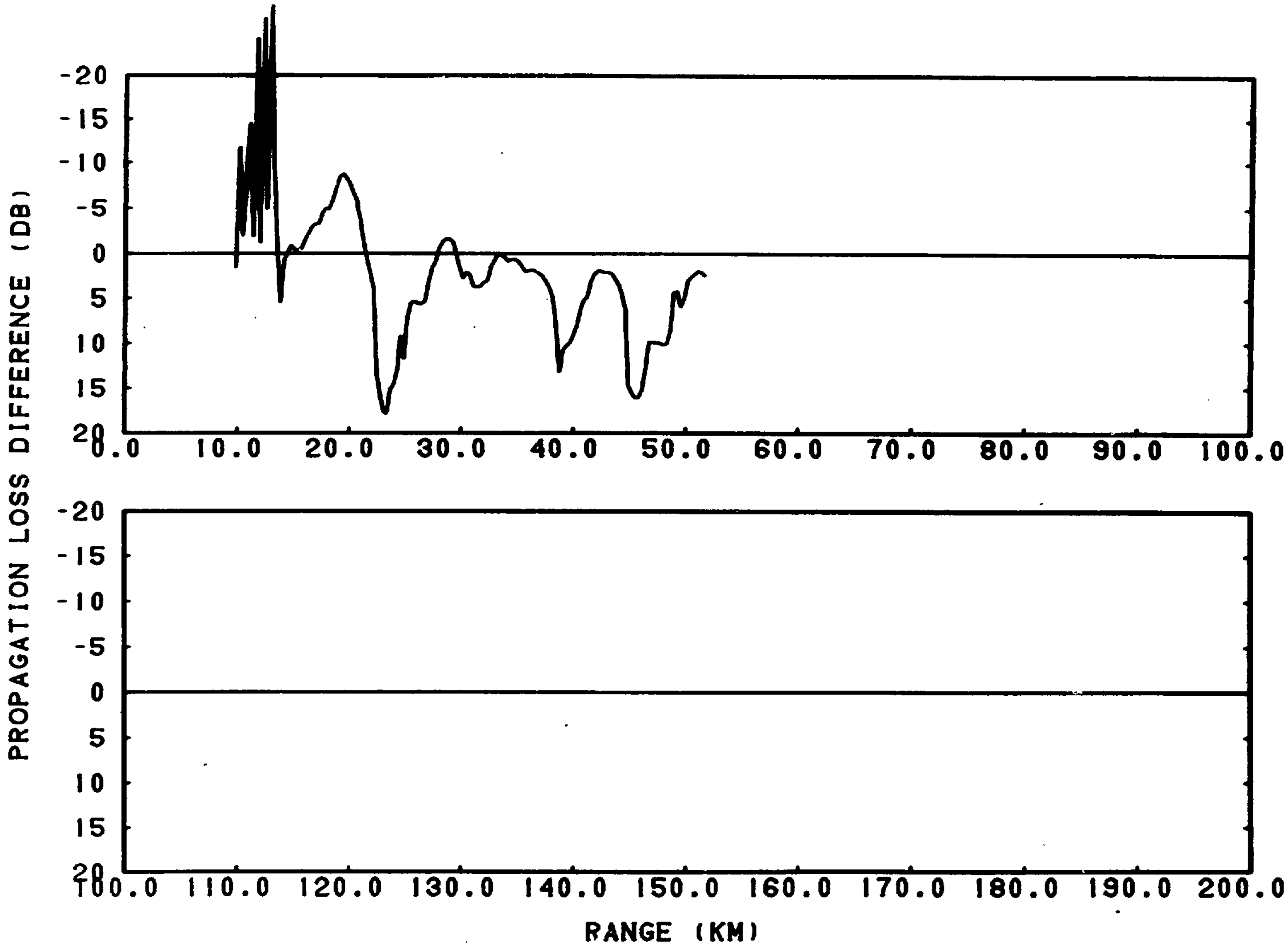
(C) Figure IIH-48. FACT Coherent, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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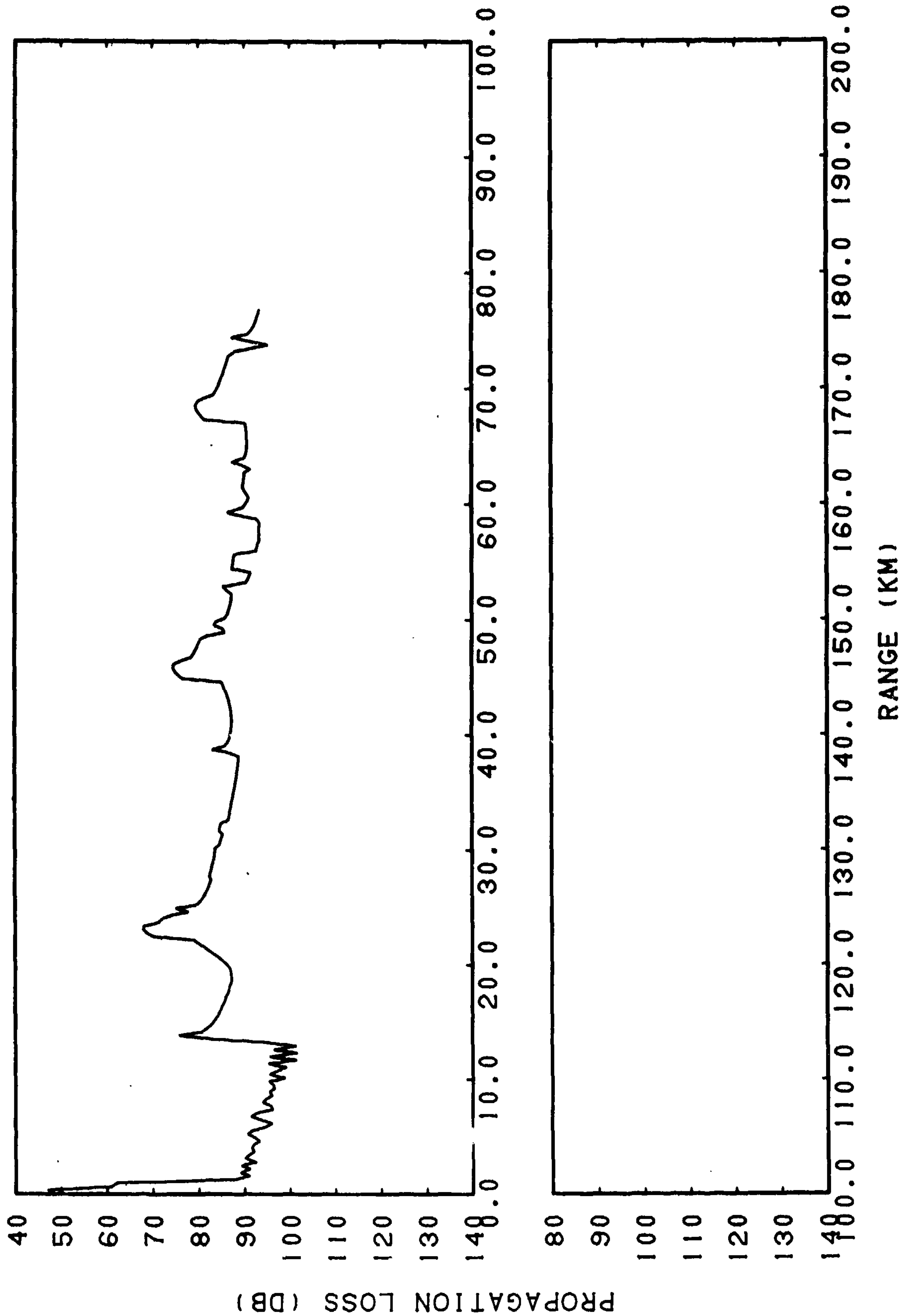
(C) Figure IIH-49. FACT Coherent, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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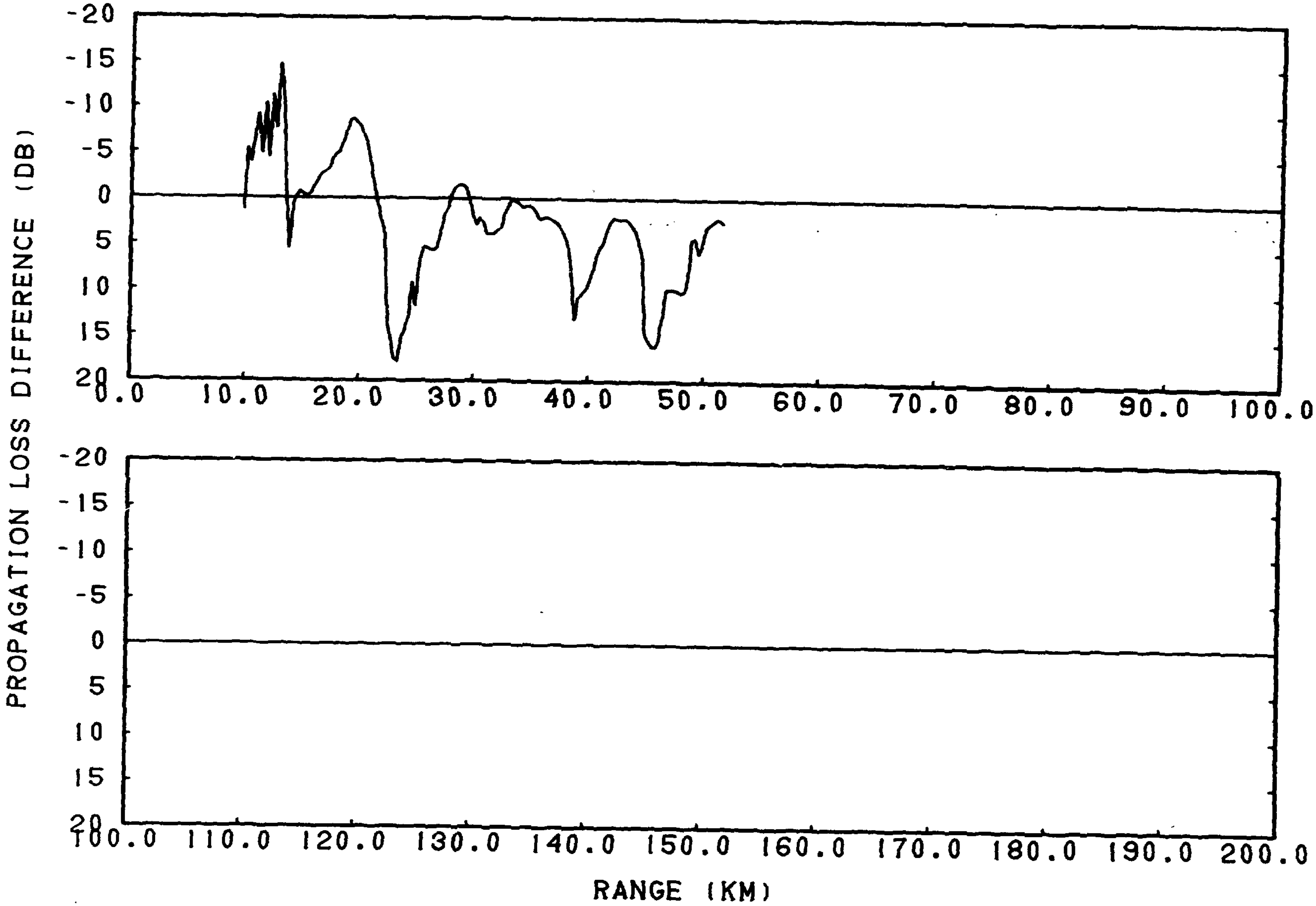
(C) Figure IIH-50. FACT Semi-coherent, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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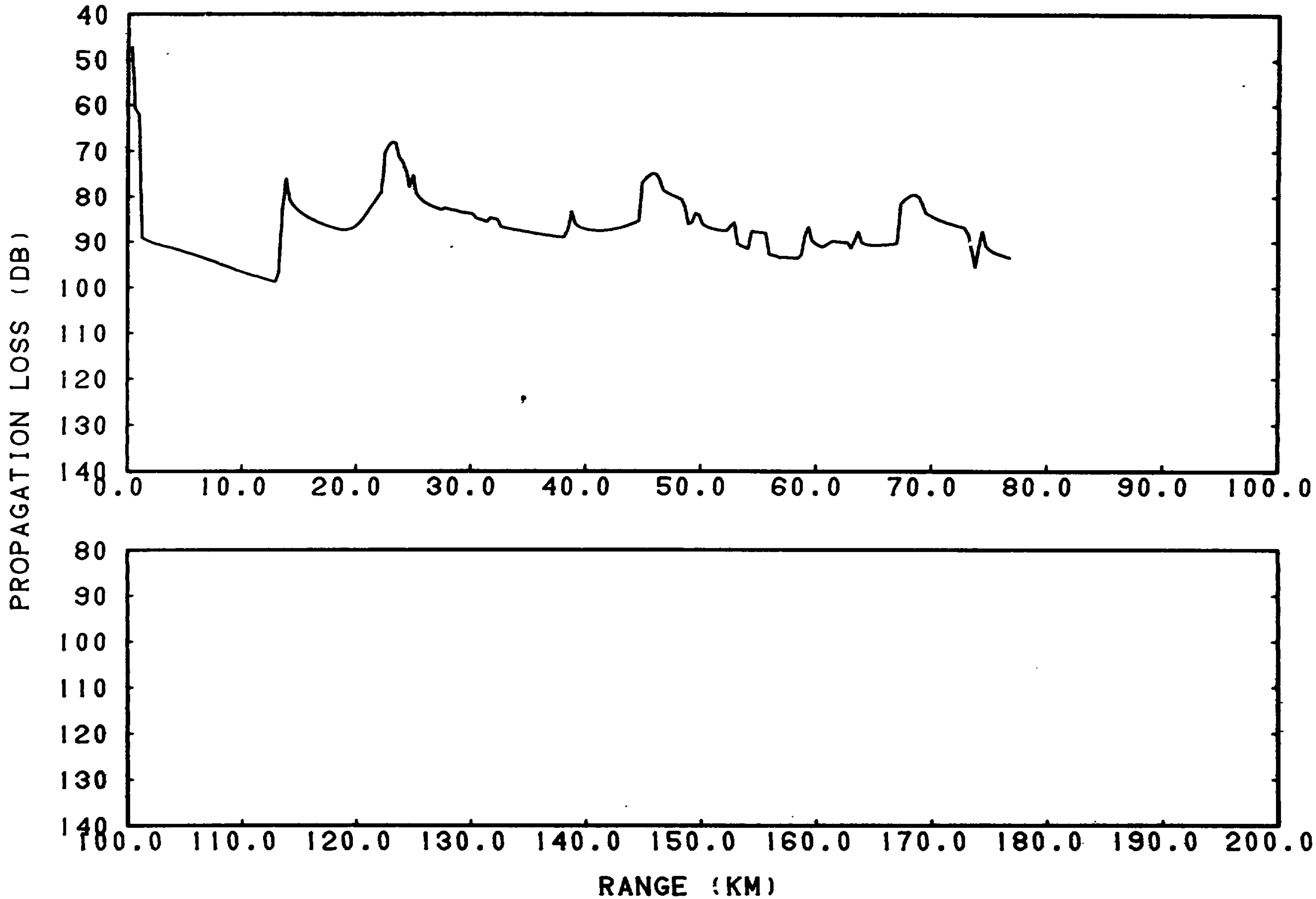
(C) Figure IIH-51. FACT Semi-coherent, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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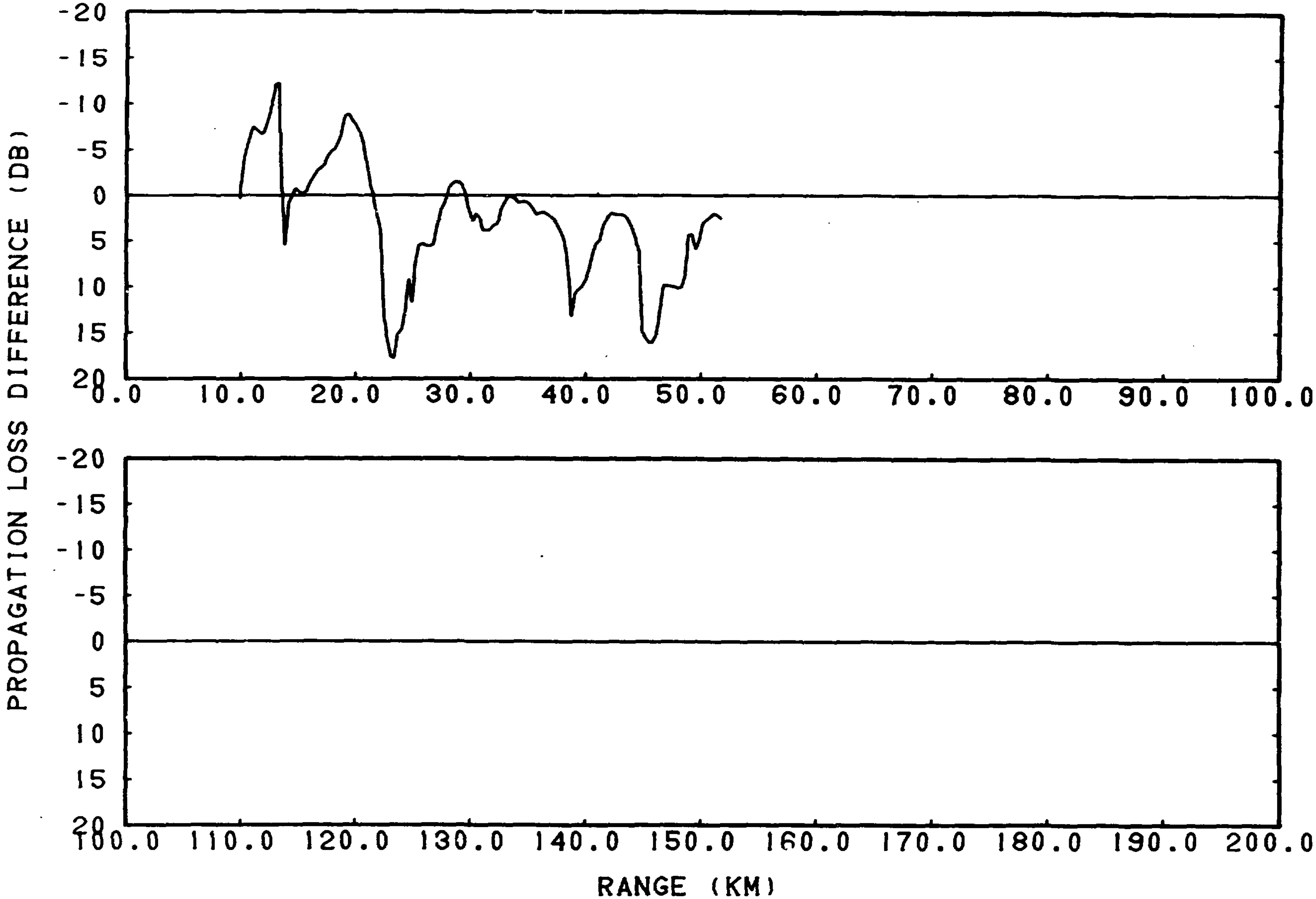
(C) Figure IIH-52. FACT Incoherent, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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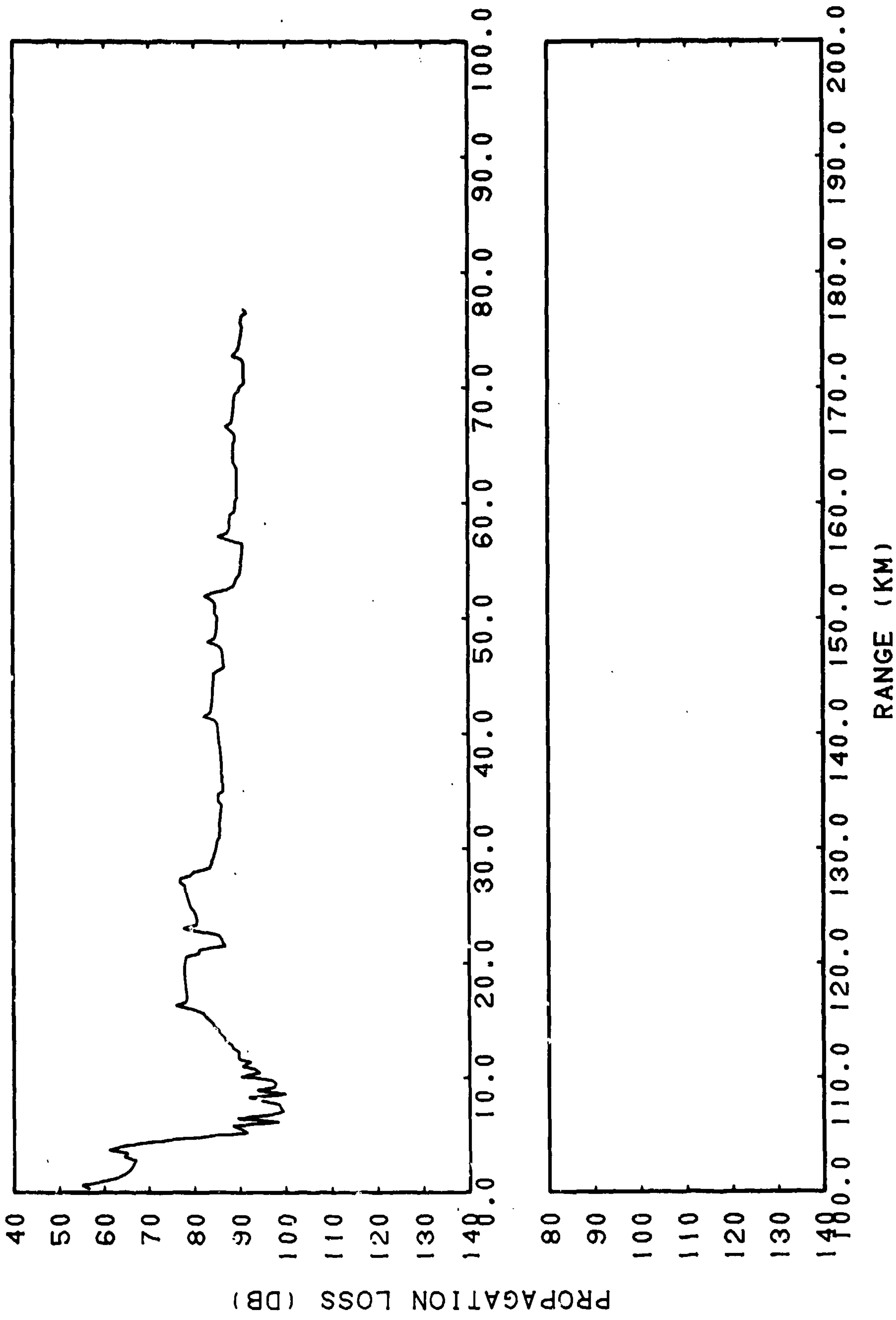
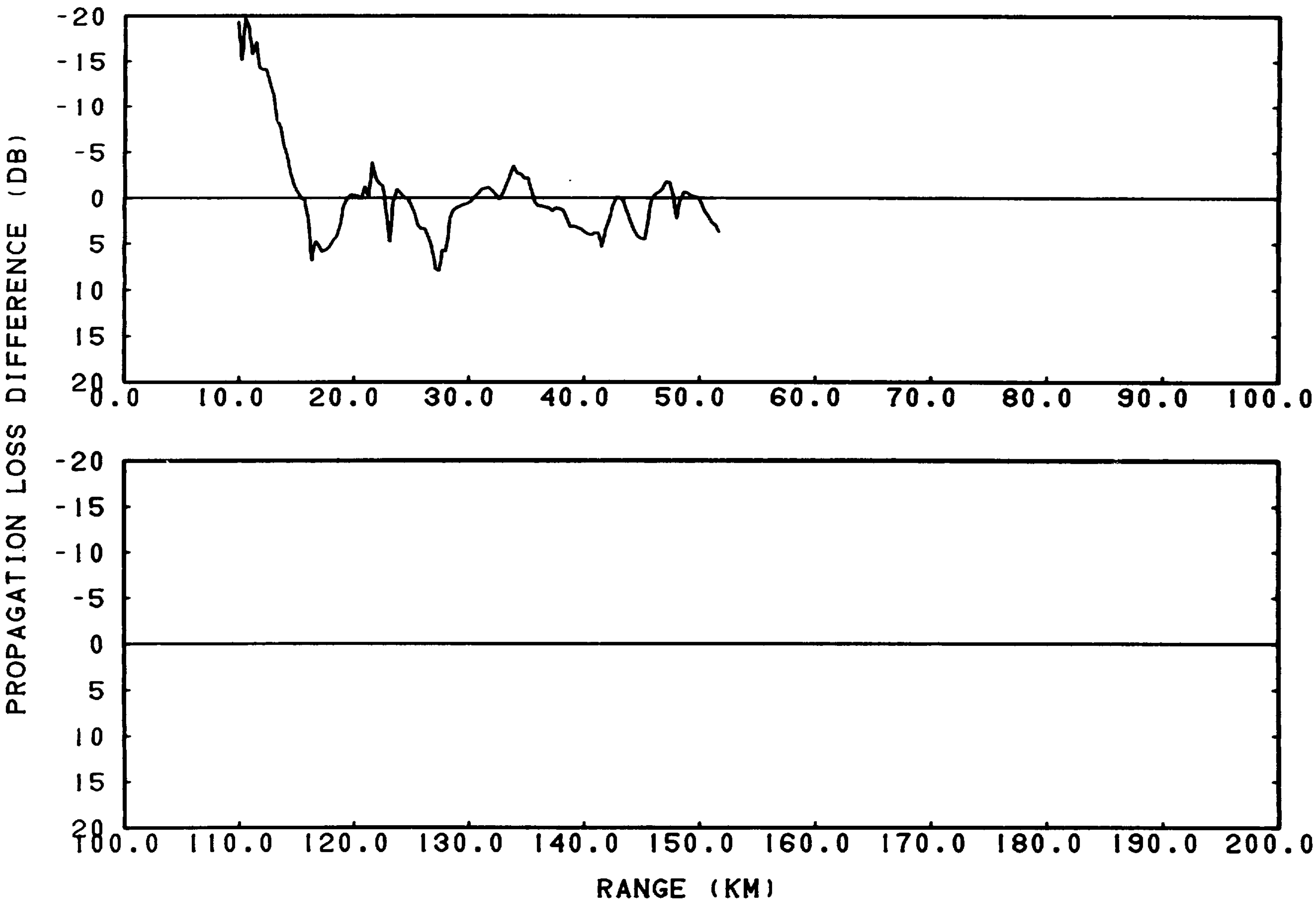
(C) Figure IIH-53. FACT Incoherent, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



(C) Figure IIIH-54. FACT Coherent, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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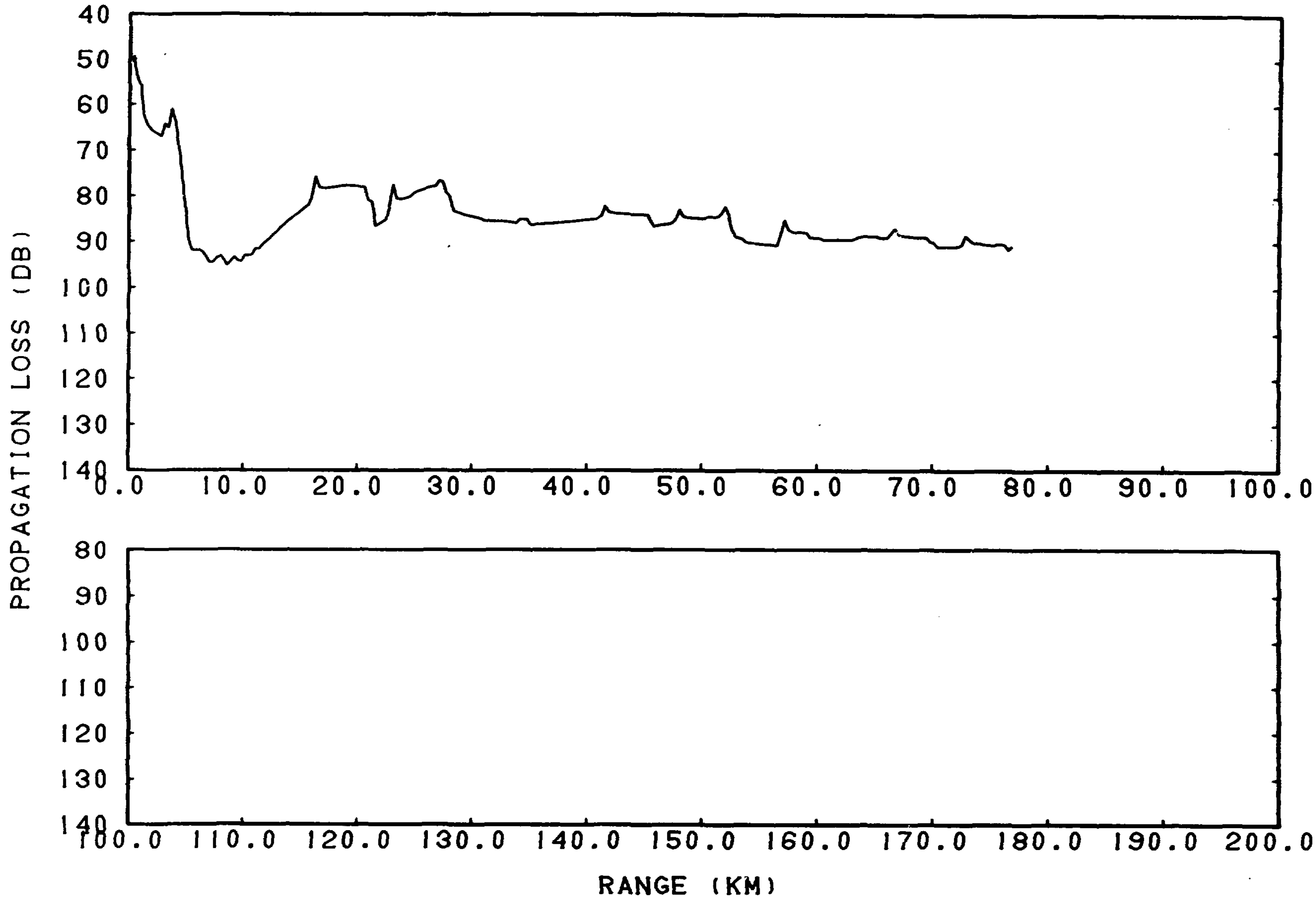
(C) Figure IIH-55. FACT Coherent, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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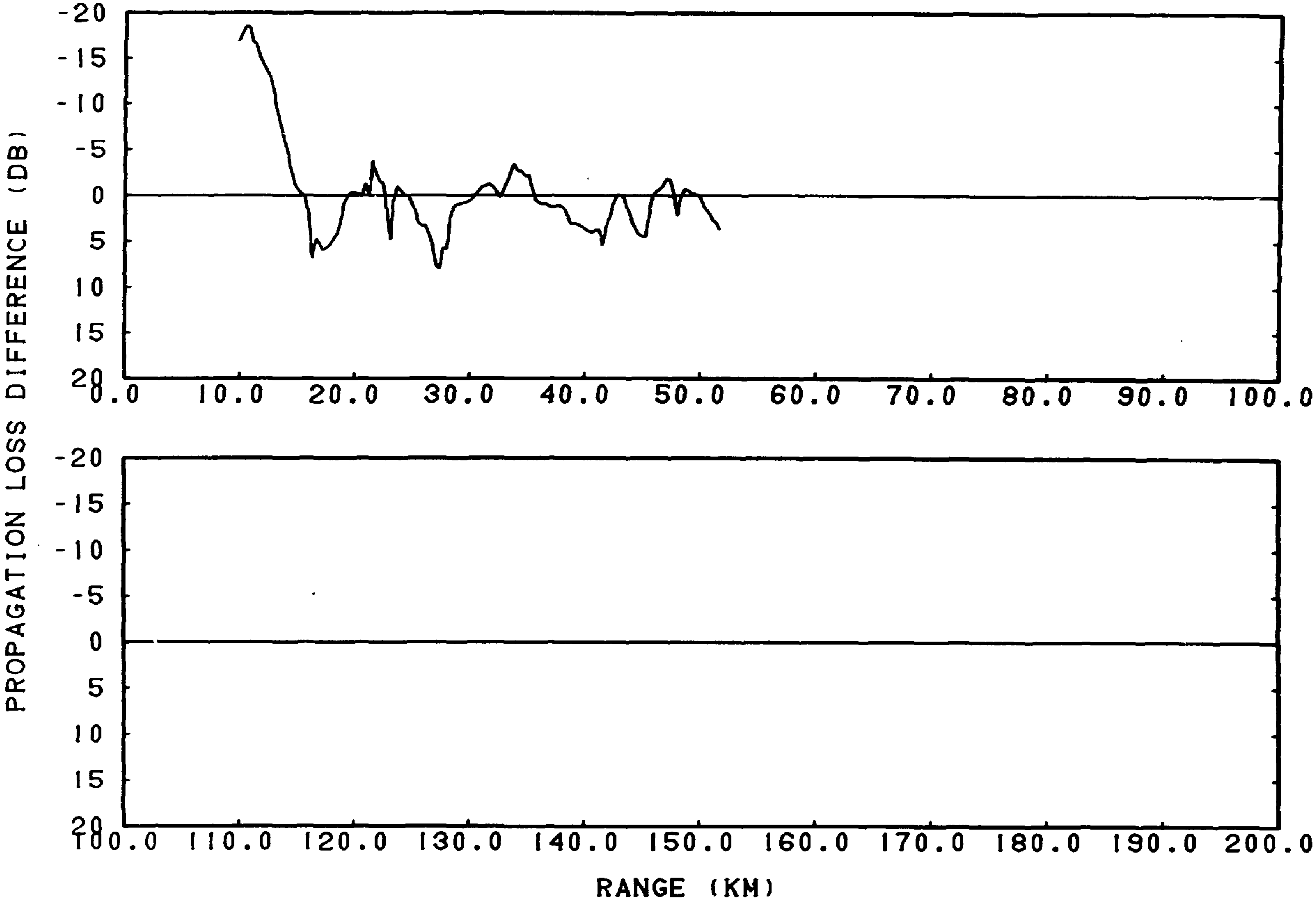
(C) Figure IIH-56. FACT Semi-coherent, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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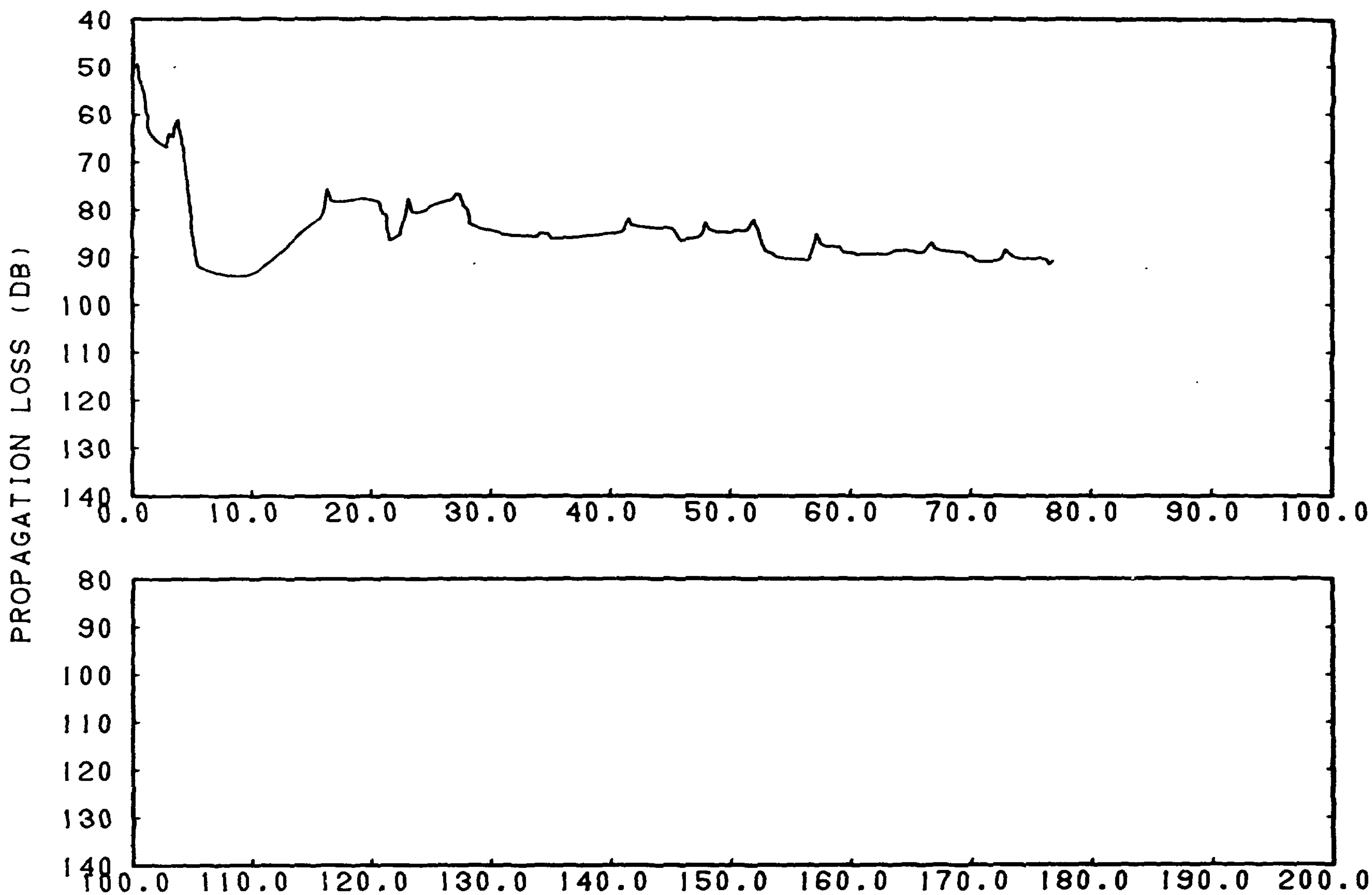
(C) Figure IIH-57. FACT Semi-coherent, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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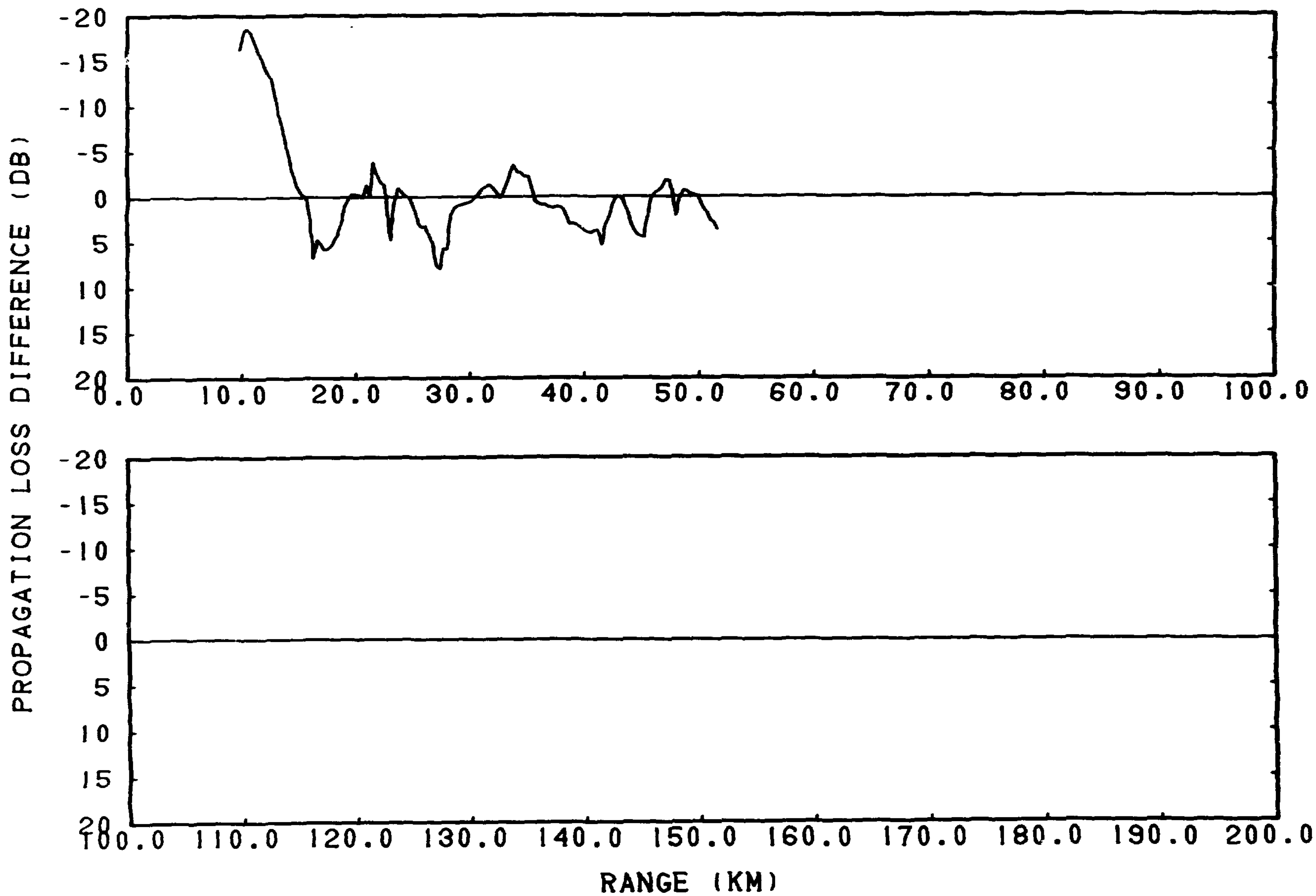
(C) Figure IIH-58. FACT Incoherent, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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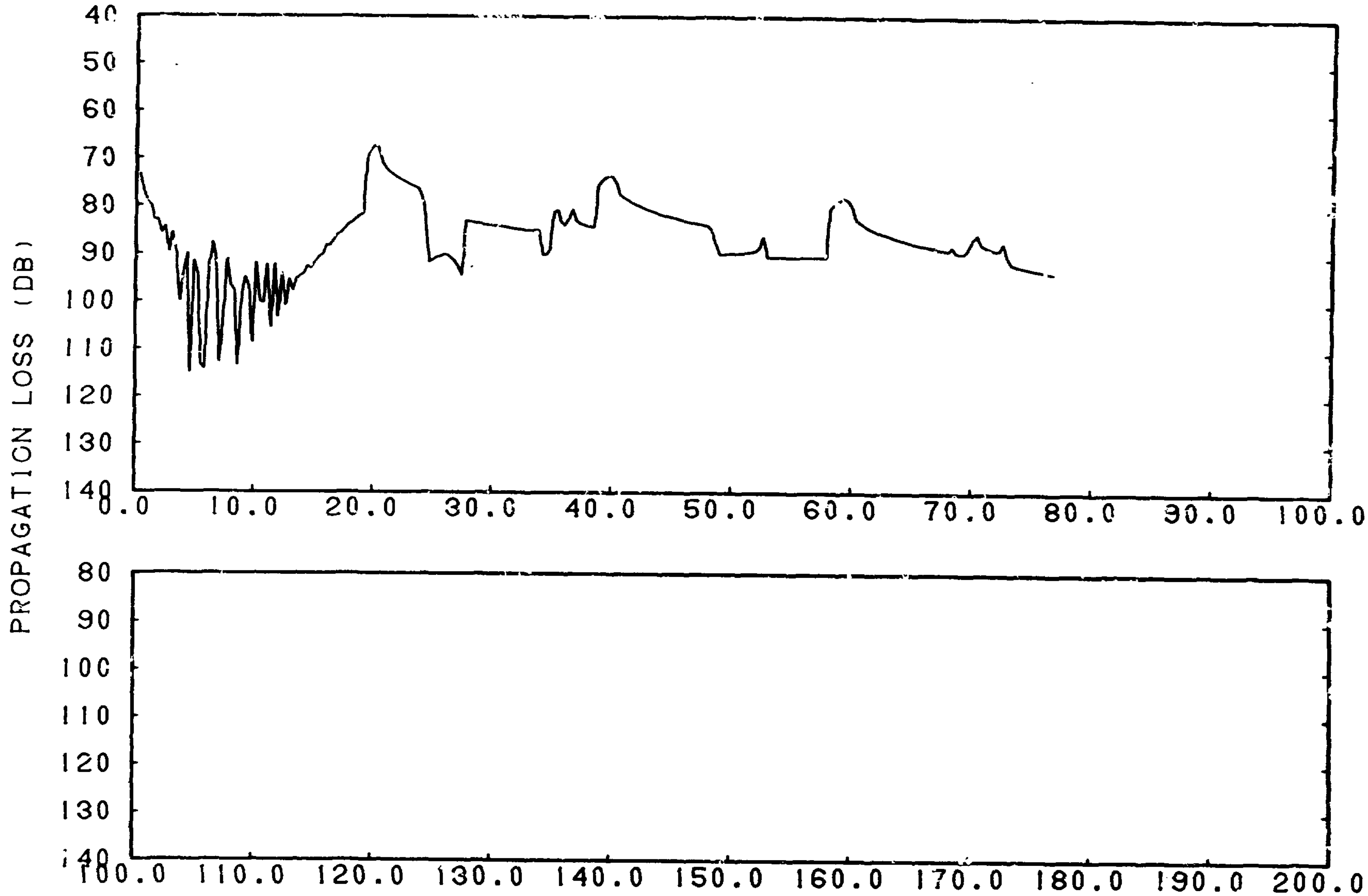
(C) Figure IIH-59. FACT Incoherent, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 143, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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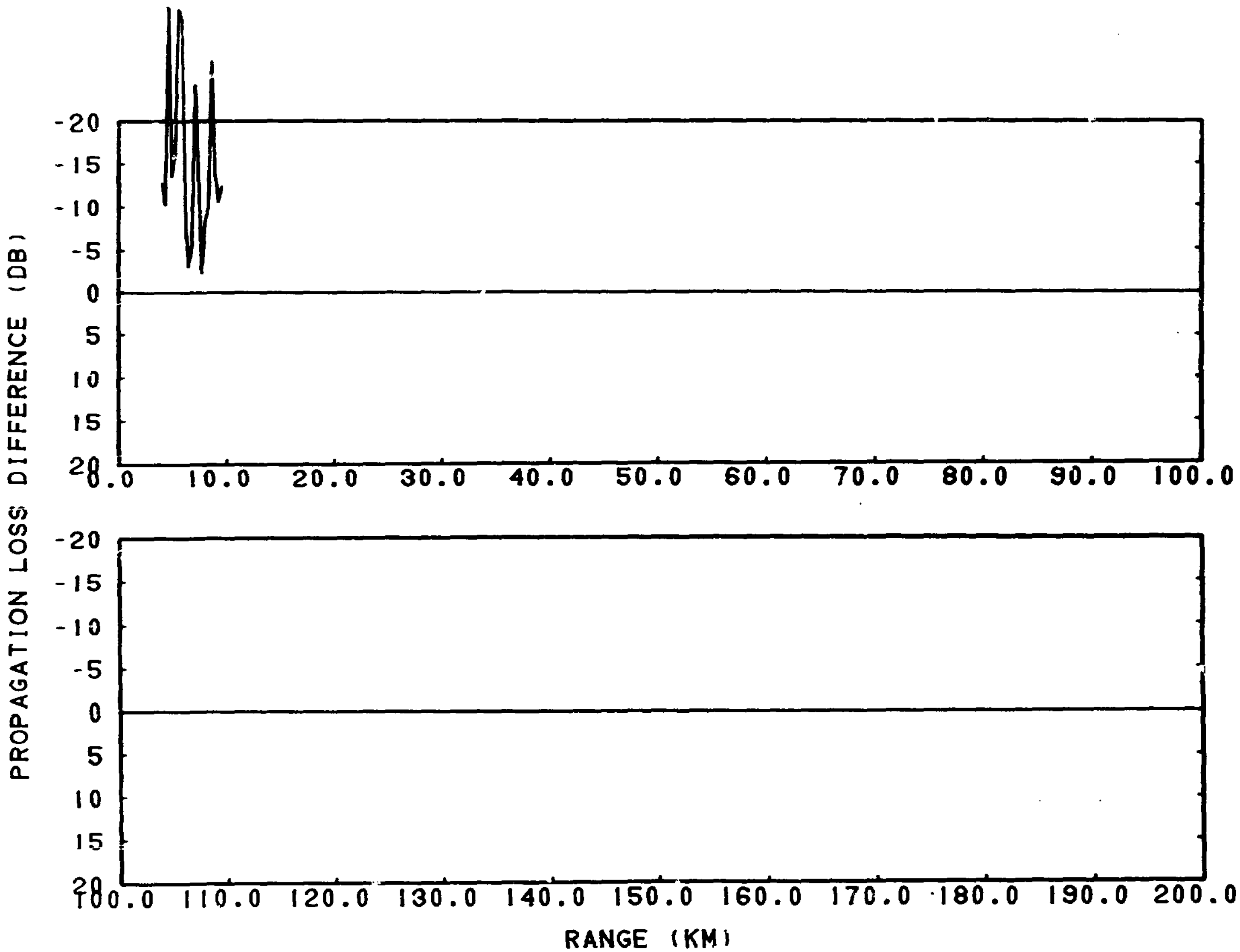
(C) Figure IIH-60. FACT Coherent, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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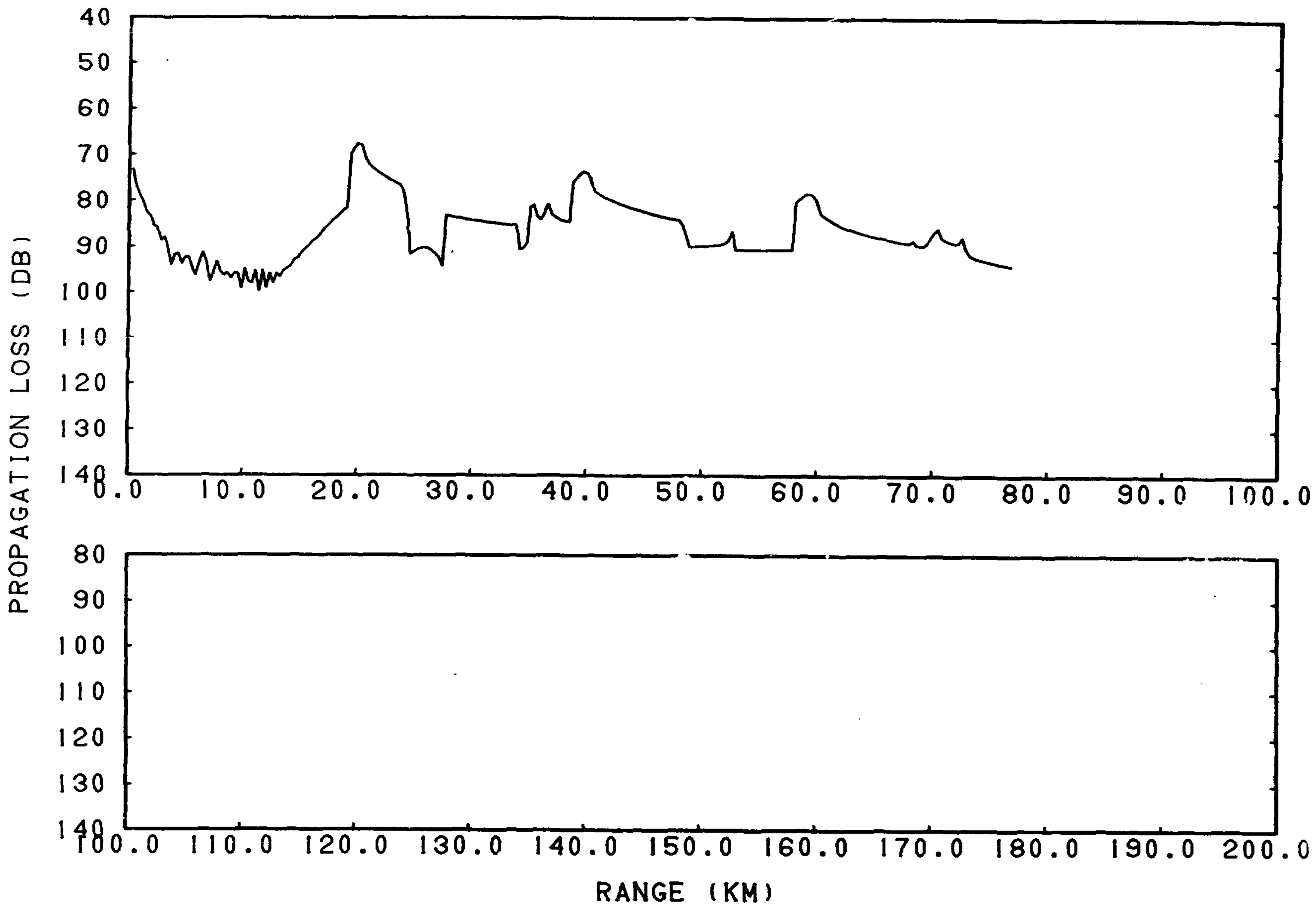
(C) Figure IIH-61. FACT Coherent, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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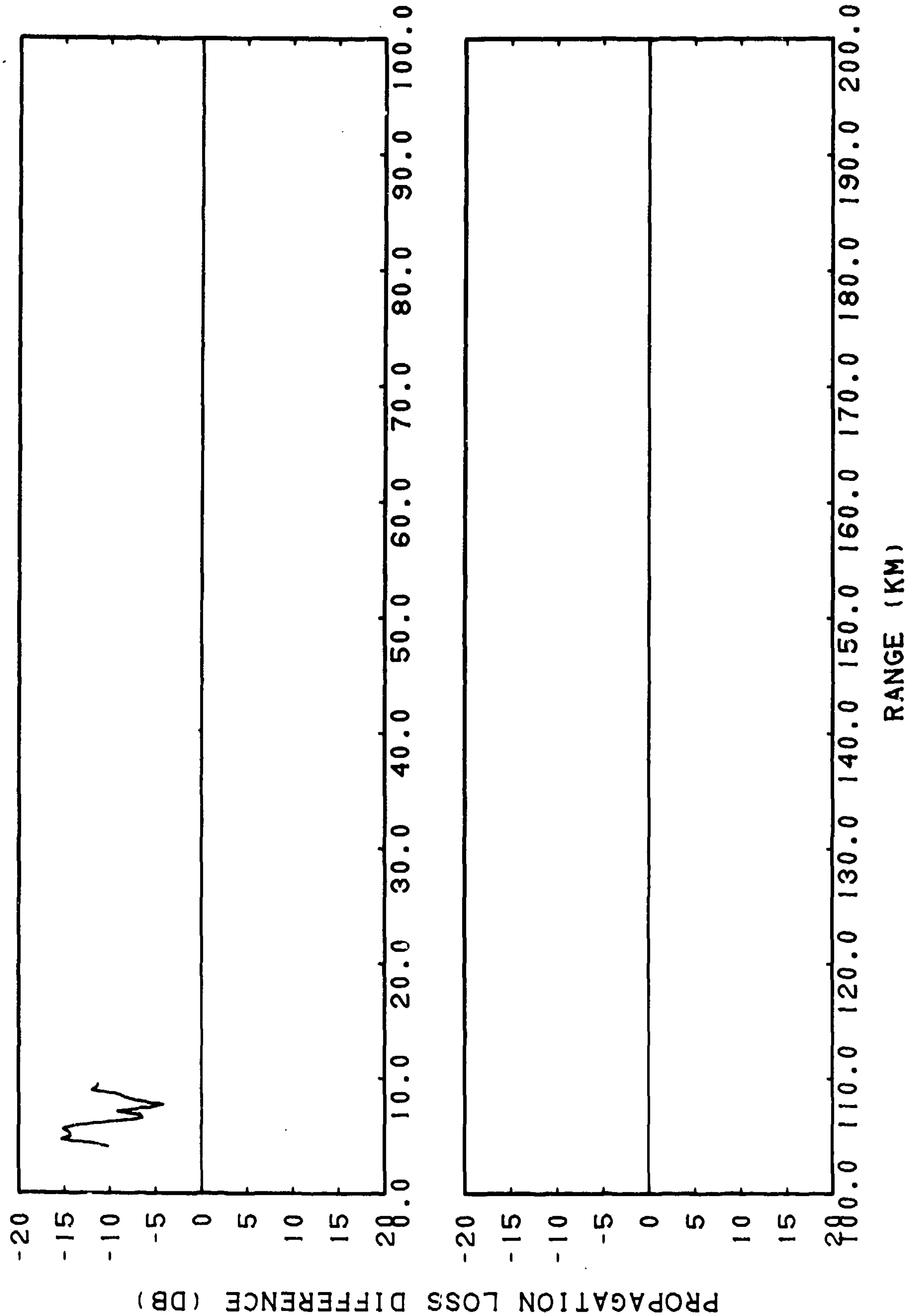
(C) Figure IIH-62. FACT Semi-coherent, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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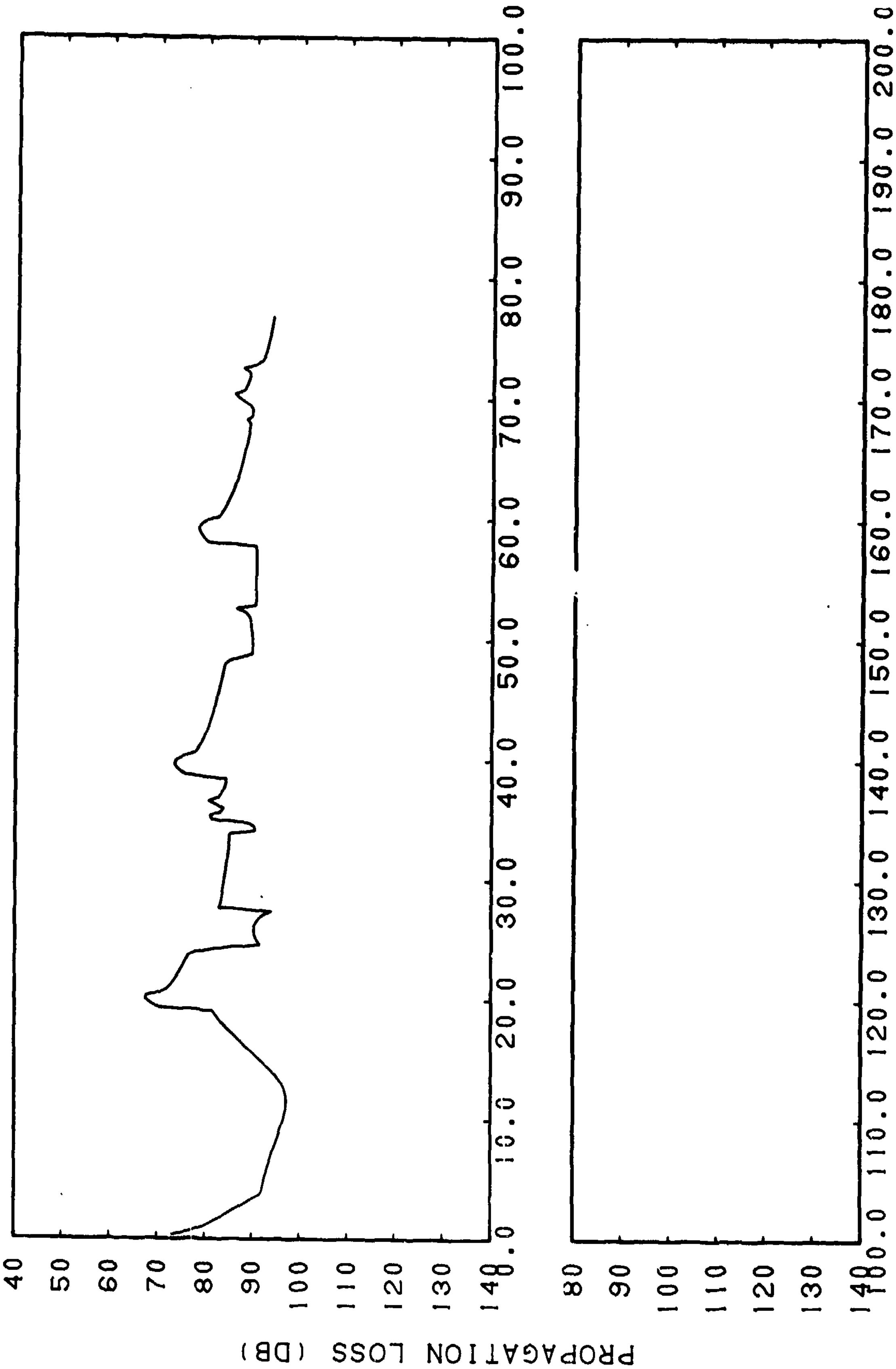
(C) Figure IIH-63. FACT Semi-coherent, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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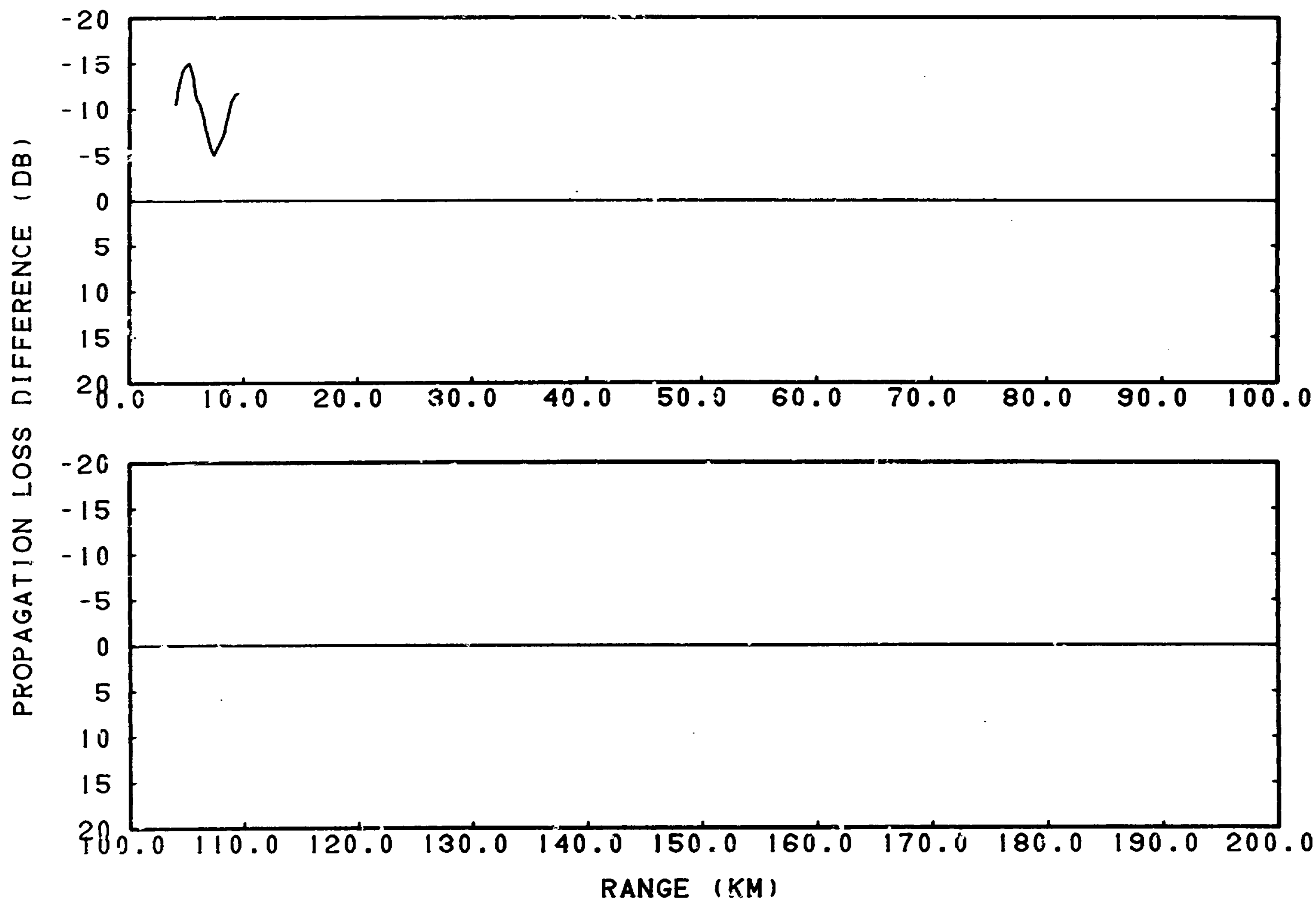
(C) Figure IIH-64. FACT Incoherent, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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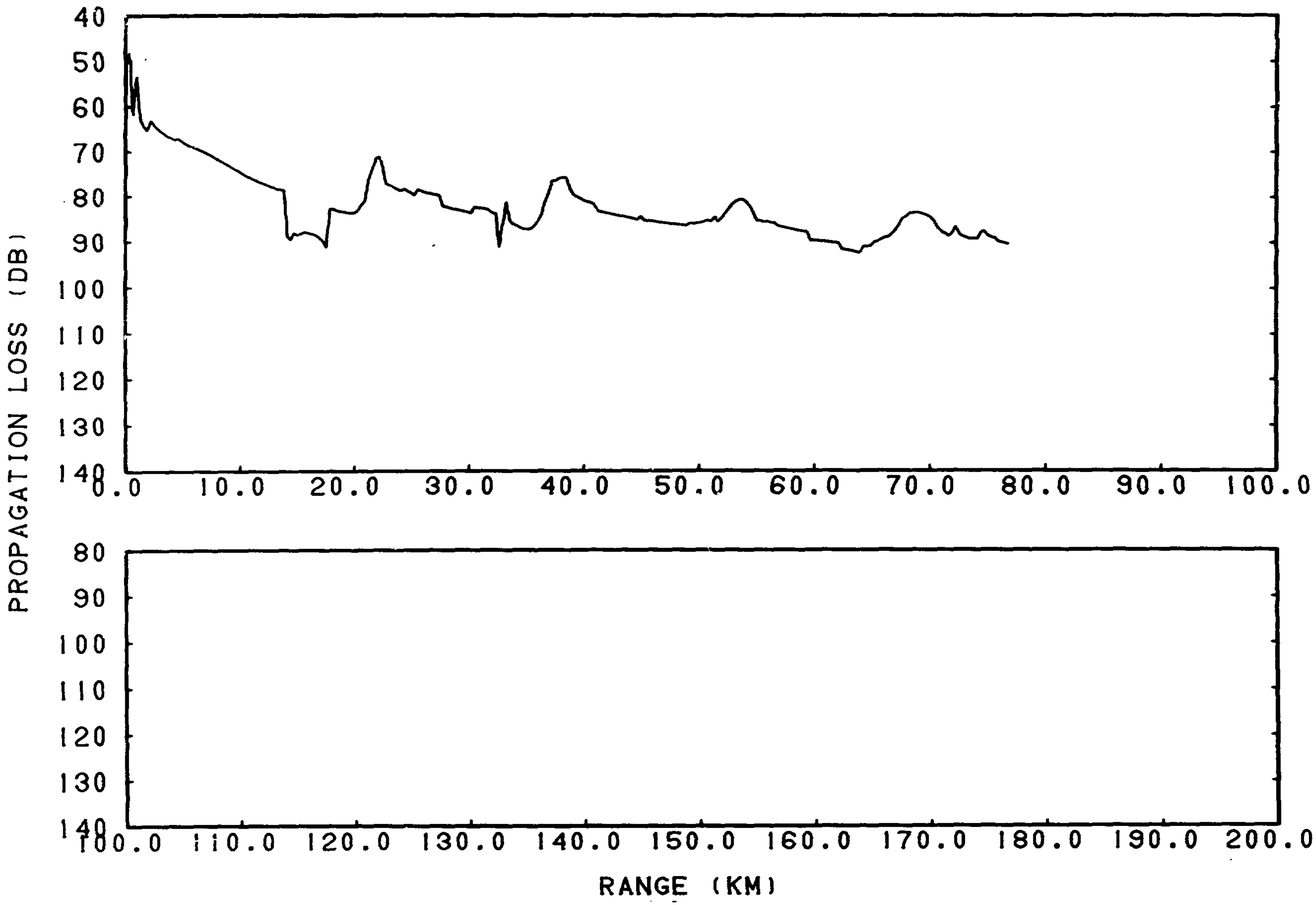
(C) Figure IIH-65. FACT Incoherent, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 30.5 Meters, Frequency = 1.5 Kilohertz



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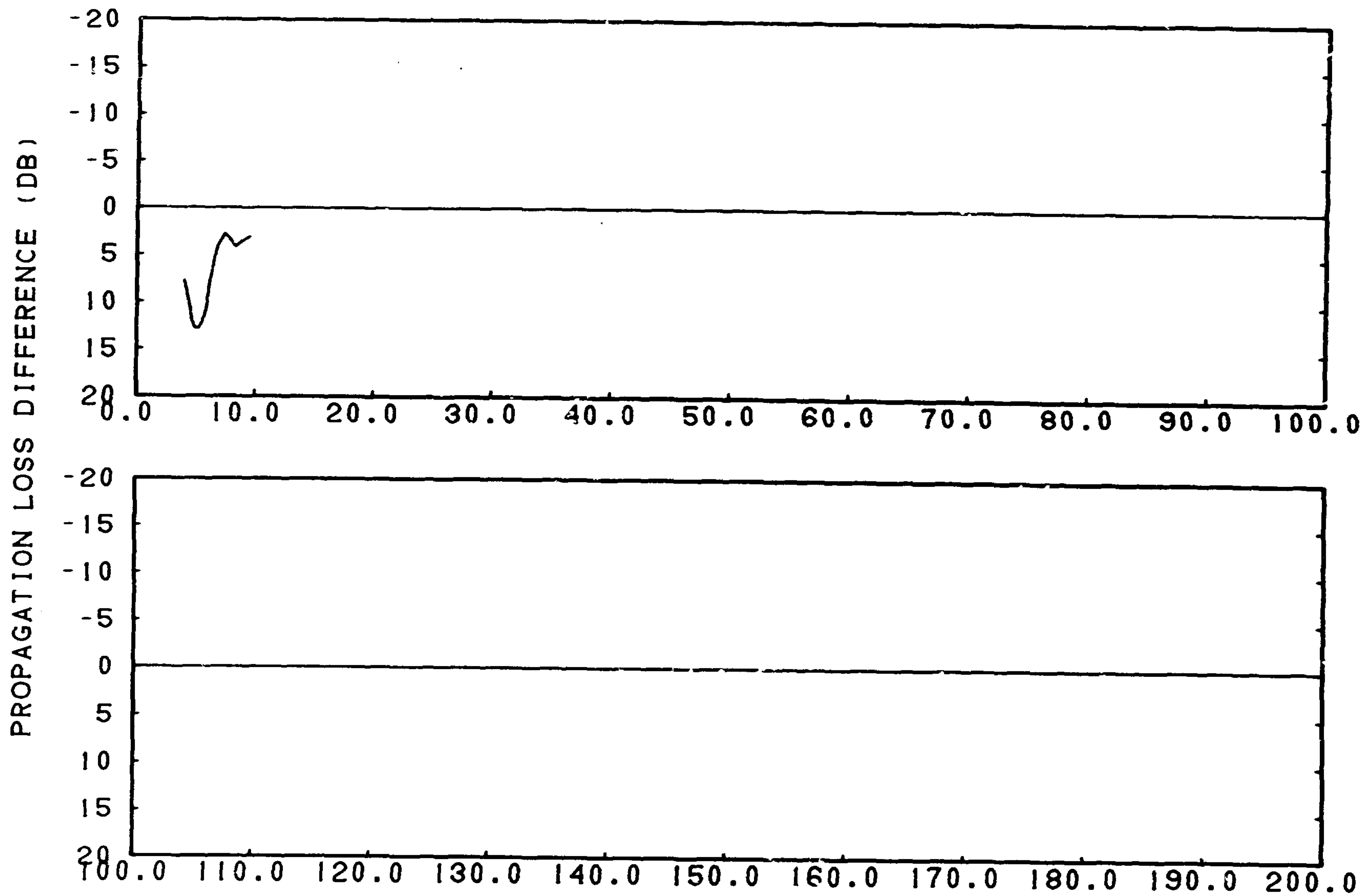
(C) Figure IIH-66. FACT Coherent, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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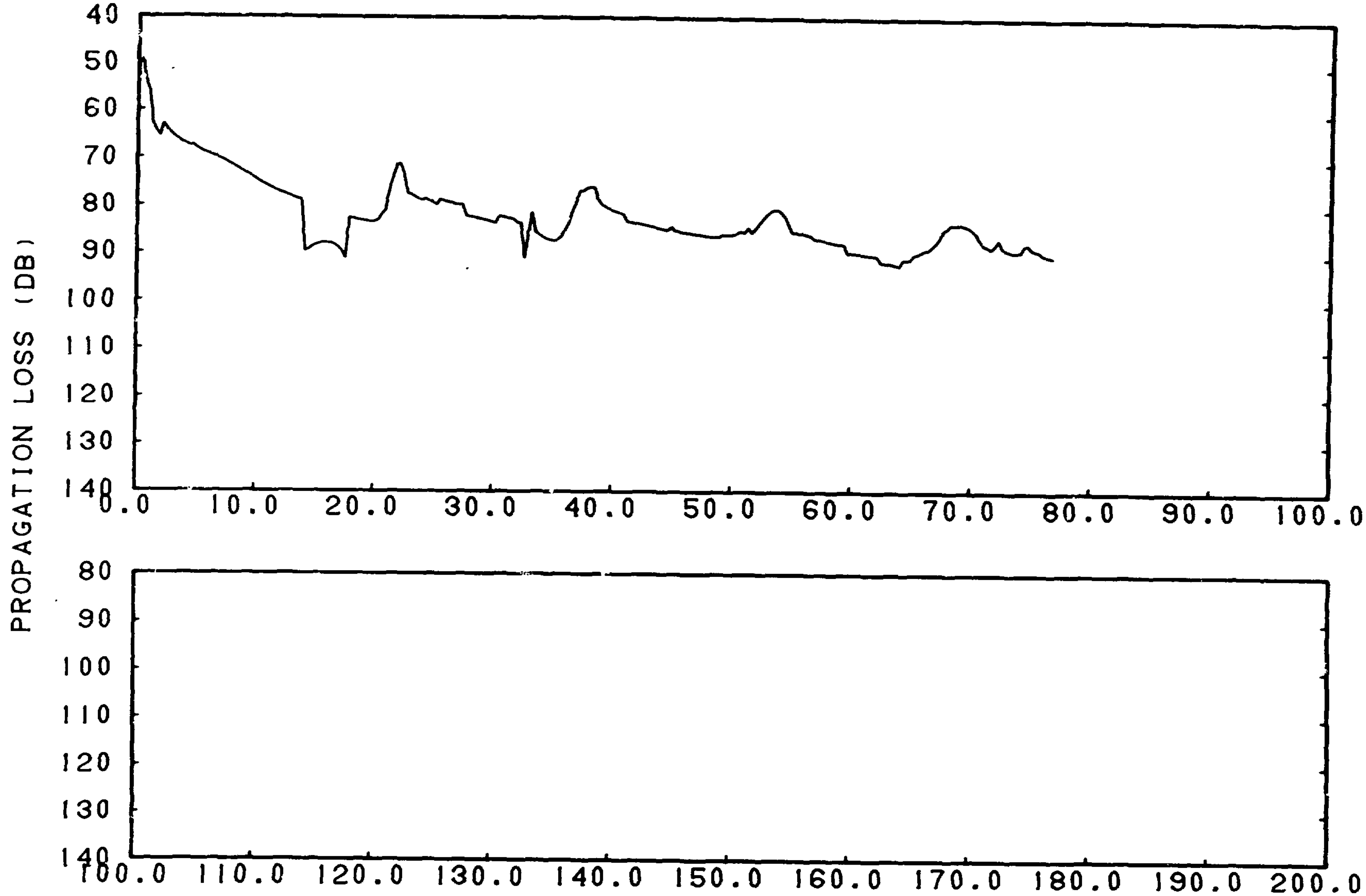
(C) Figure IIH-67. FACT Coherent, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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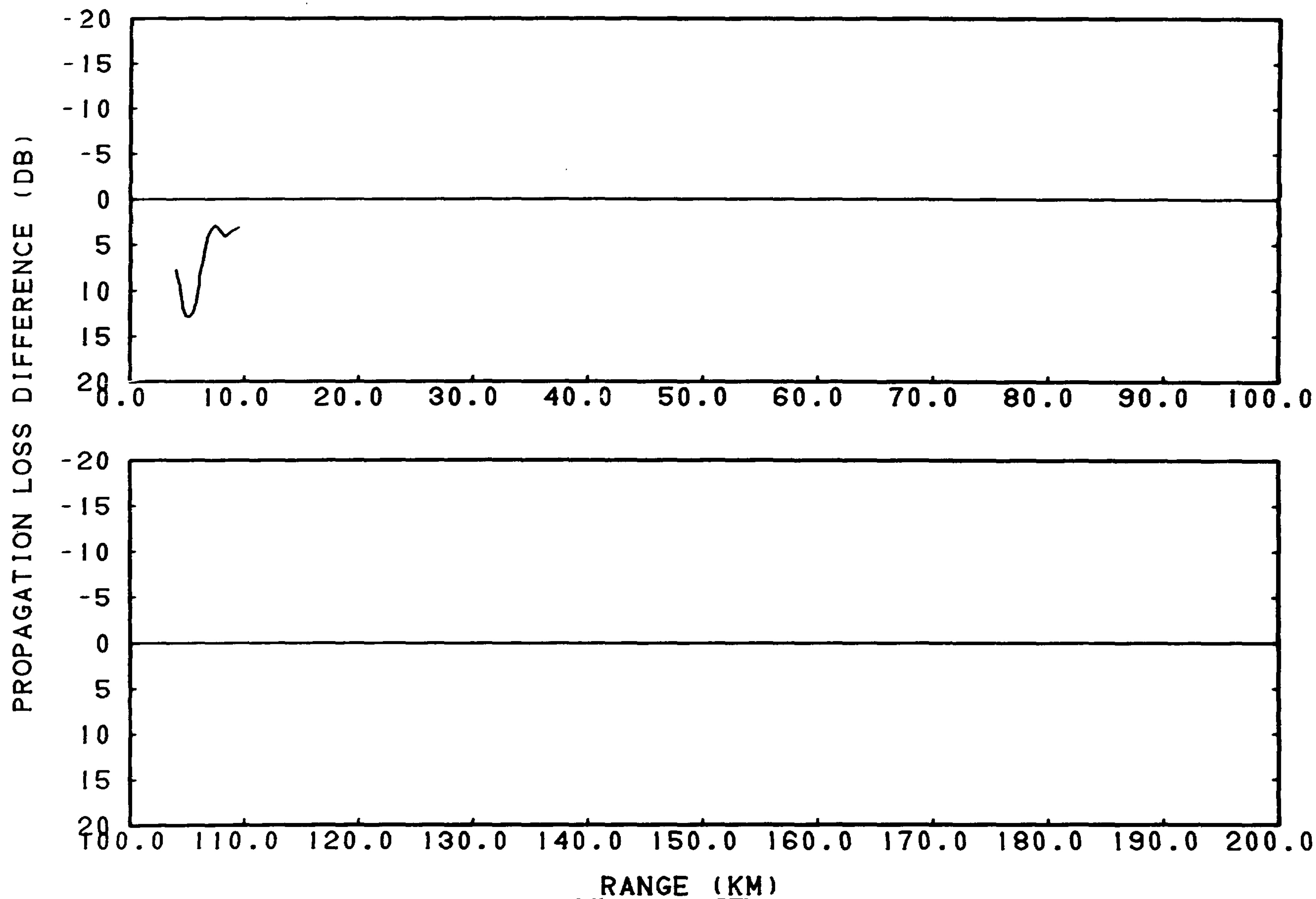
(C) Figure IIH-68. FACT Semi-coherent, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 *Kilohertz*



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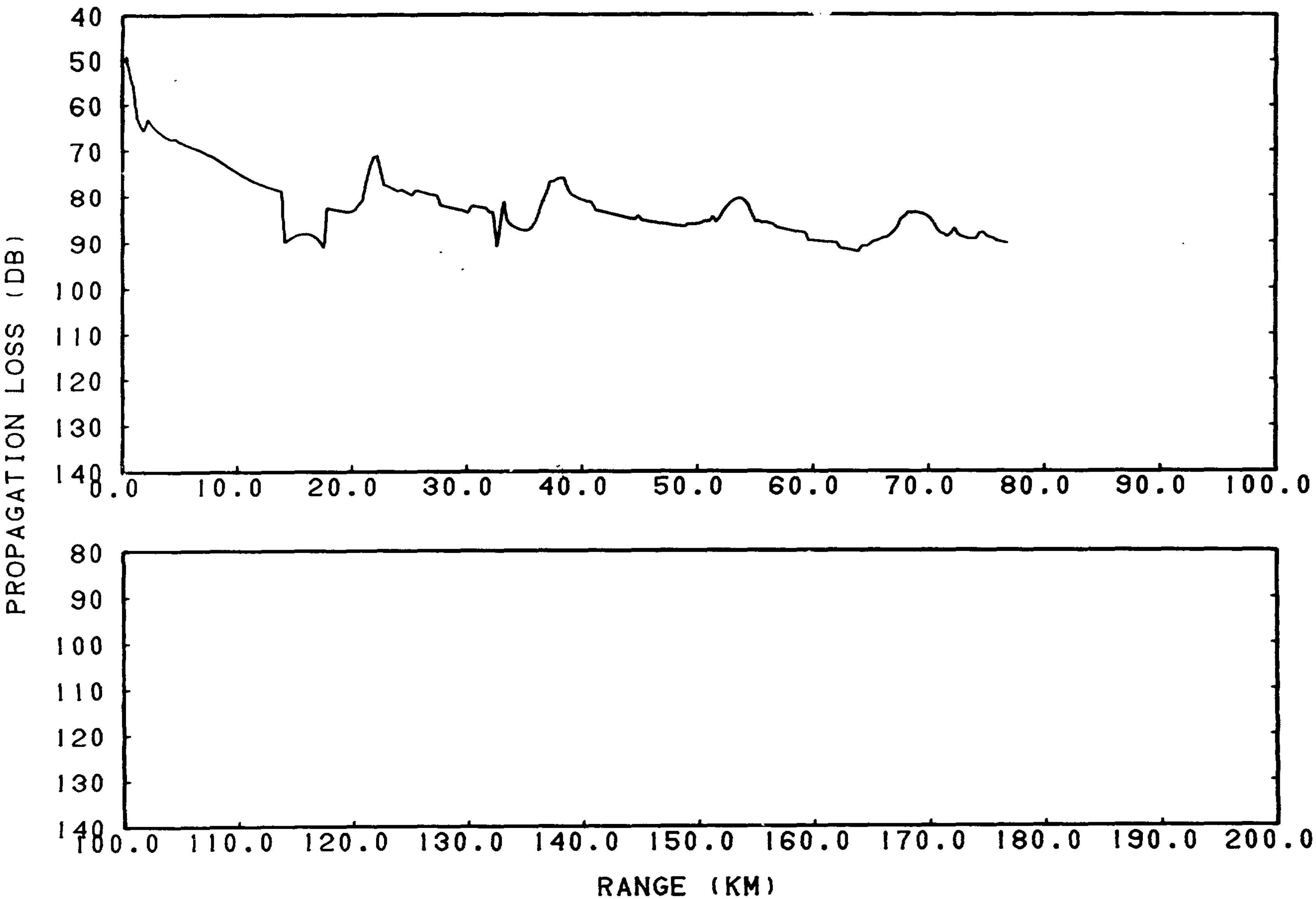
(C) Figure IIH-69. FACT Semi-coherent, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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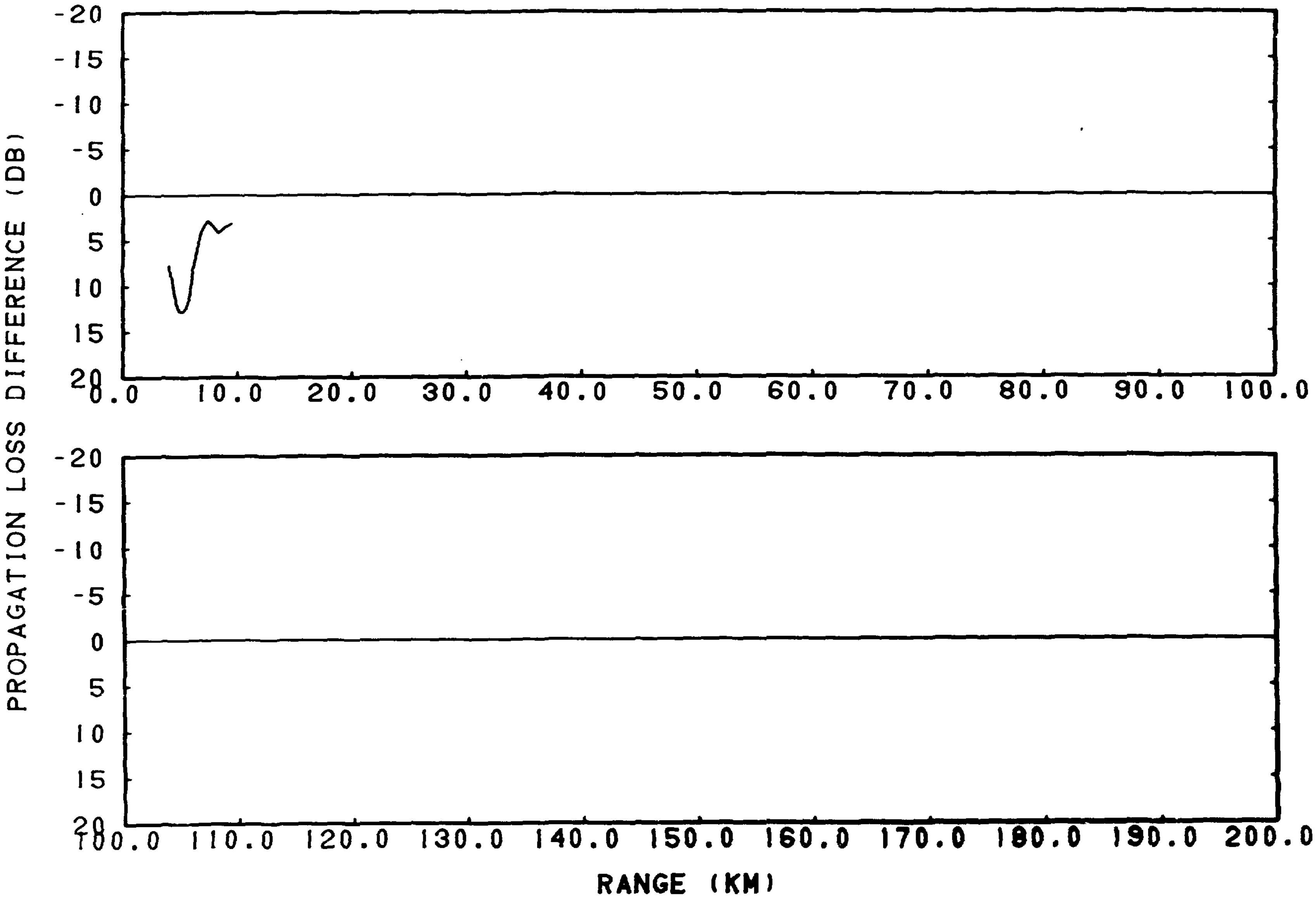
(C) Figure IIH-70. FACT Incoherent, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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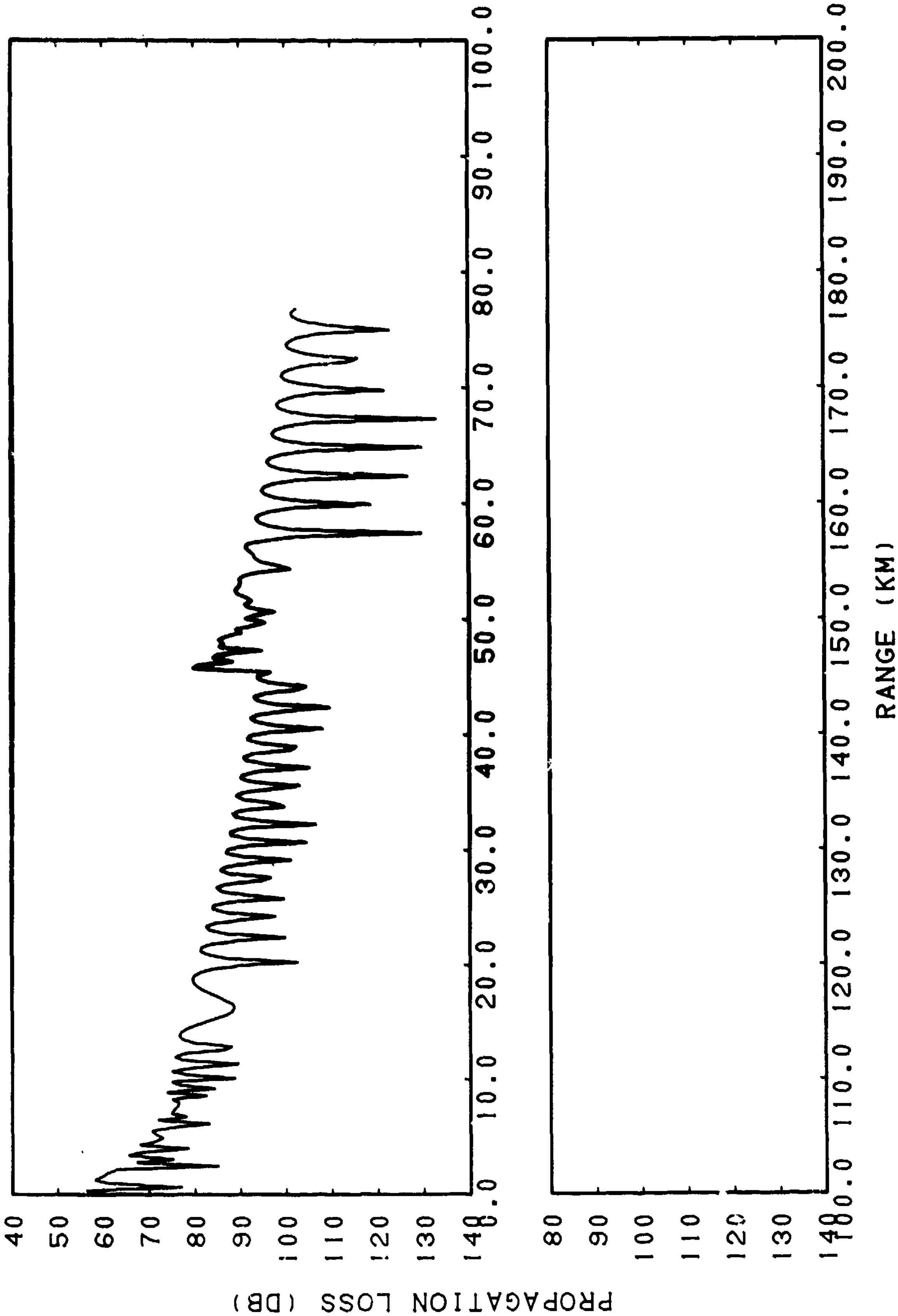
(C) Figure IIH-71. FACT Incoherent, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 124, Source Depth = 30.5 Meters, Receiver Depth = 305 Meters, Frequency = 1.5 Kilohertz



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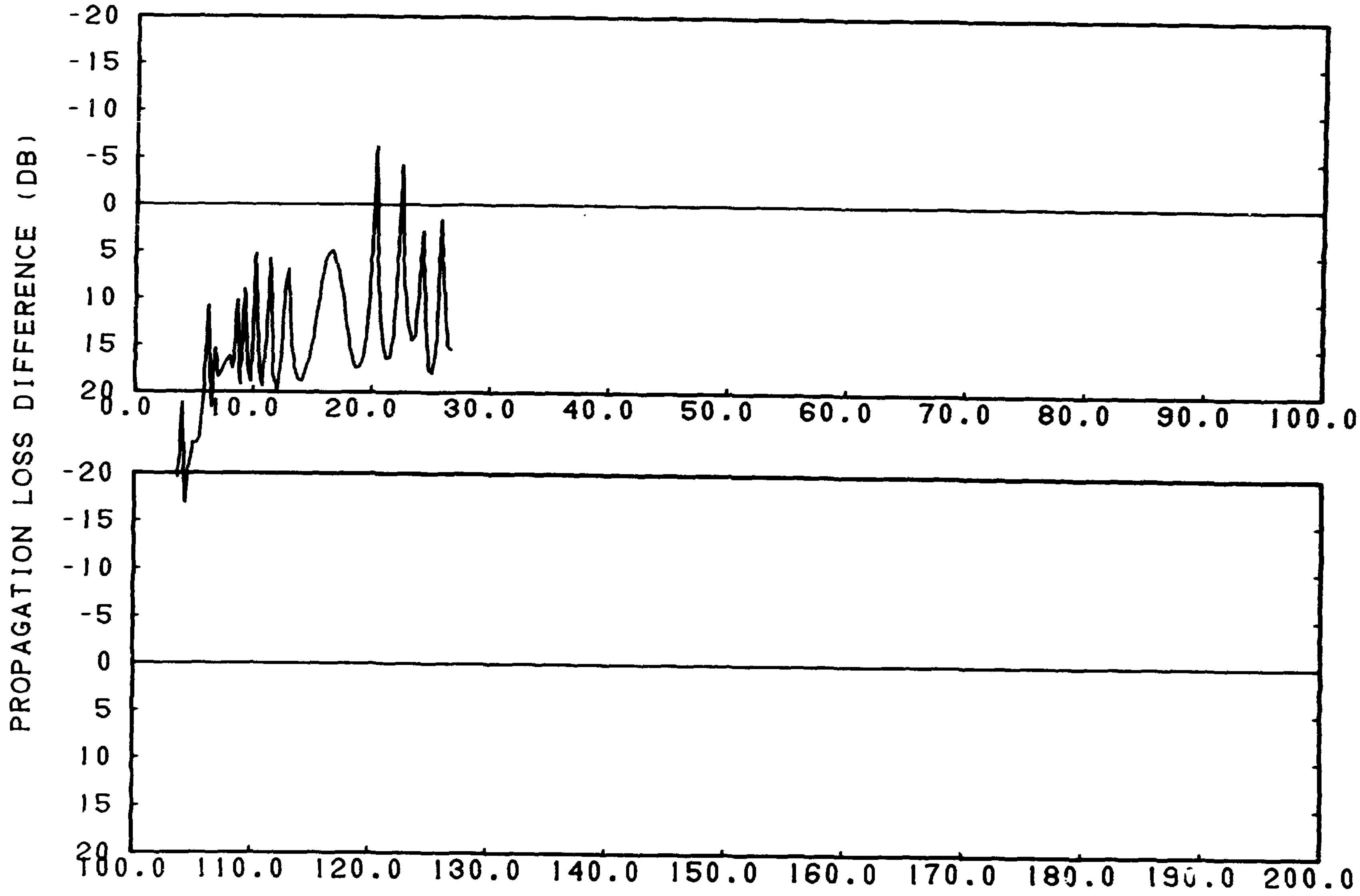
(C) Figure IIH-72. FACT Coherent, Run 108, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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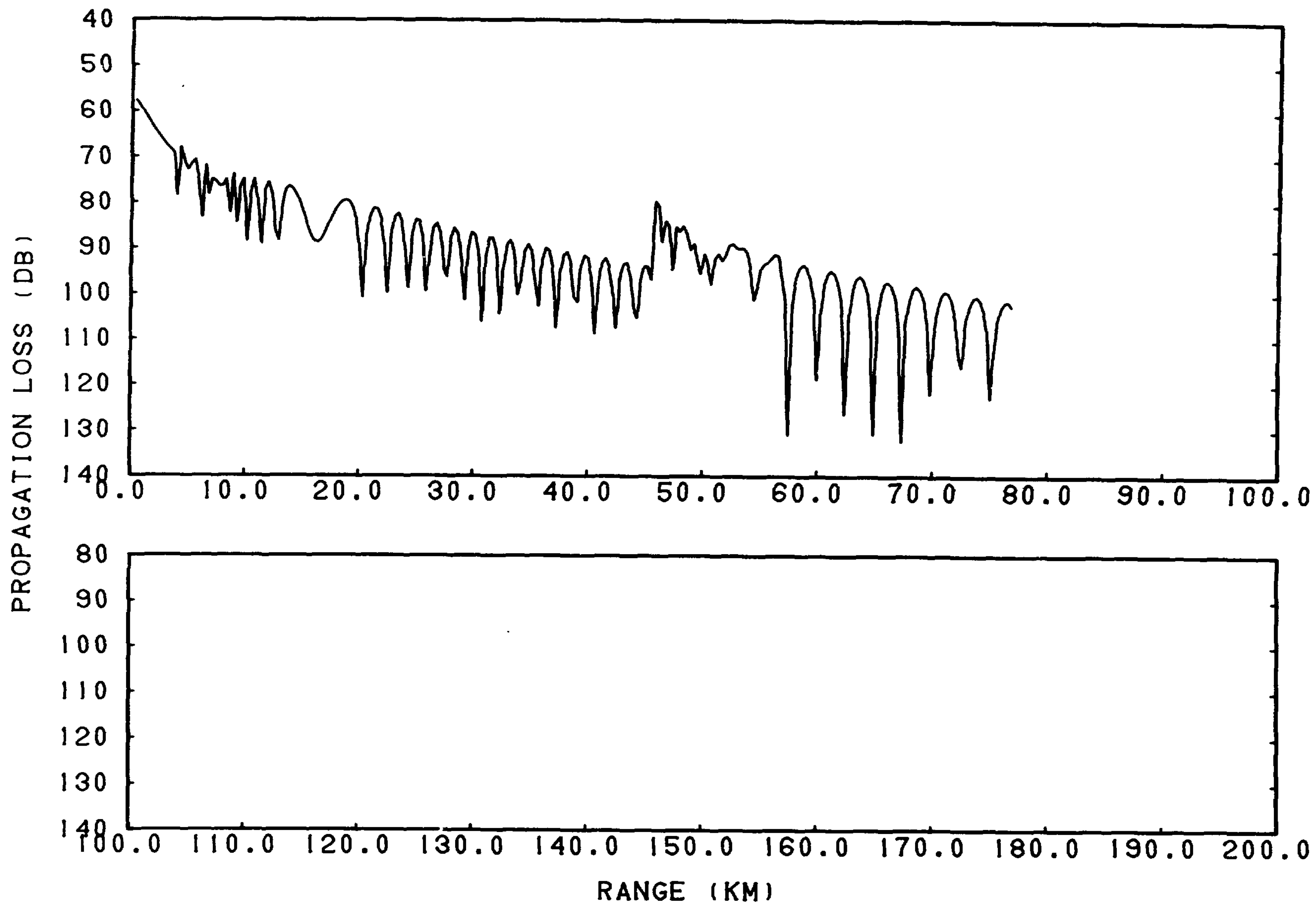
(C) Figure IIH-73. FACT Coherent, Run 108, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 108, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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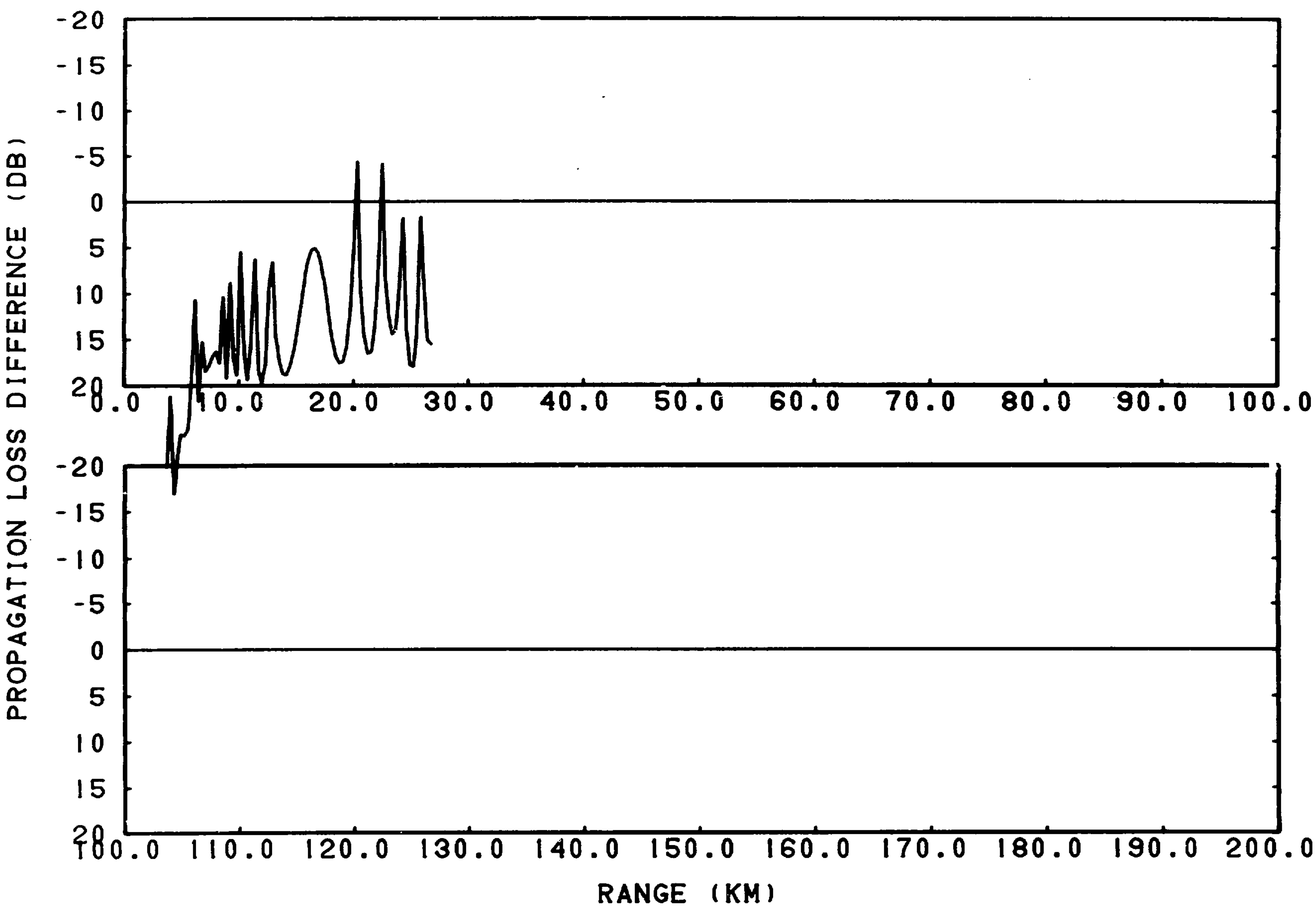
(C) Figure IIH-74. FACT Semi-coherent, Run 108, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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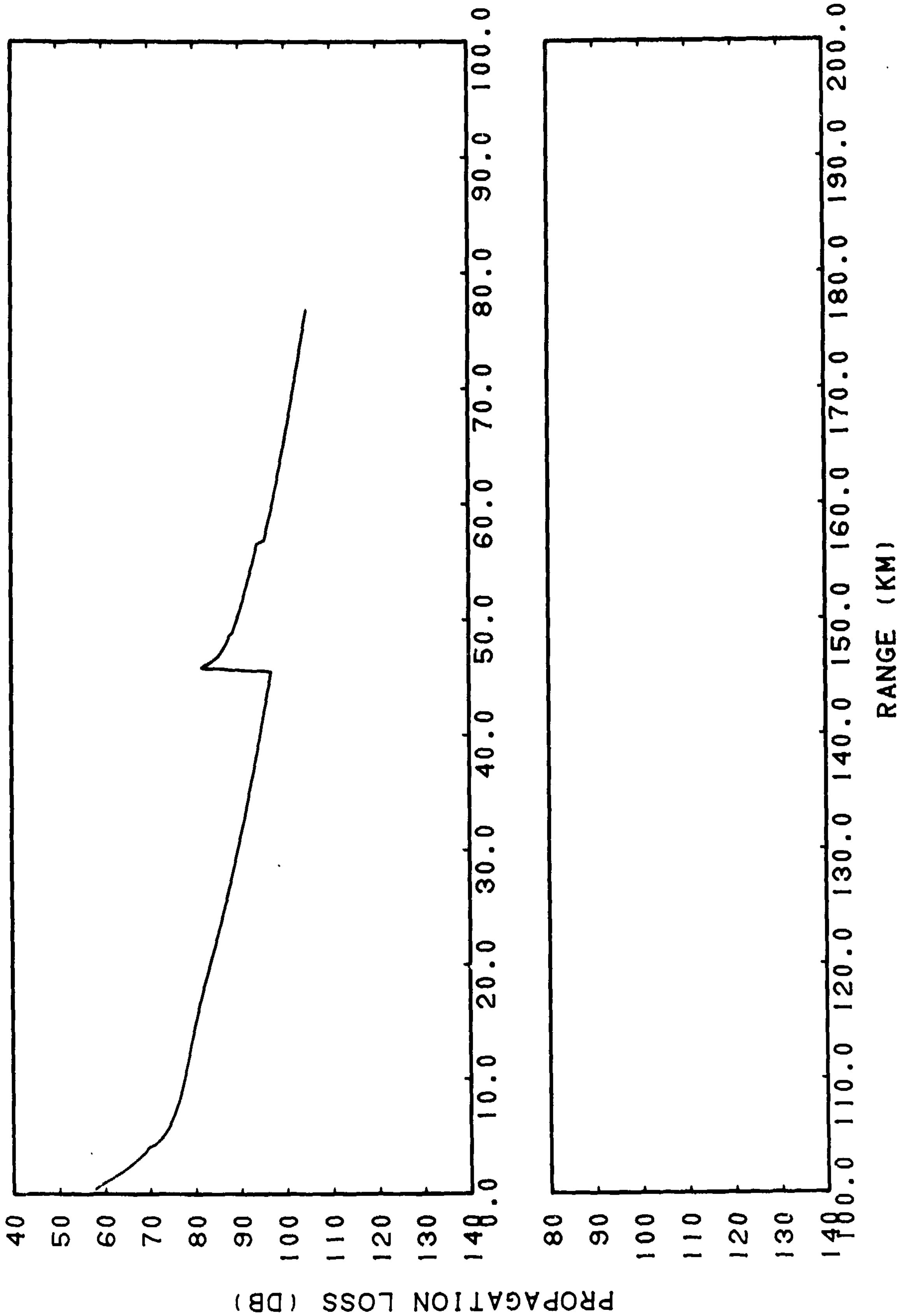
(C) Figure IIH-75. FACT Semi-coherent, Run 108, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 108, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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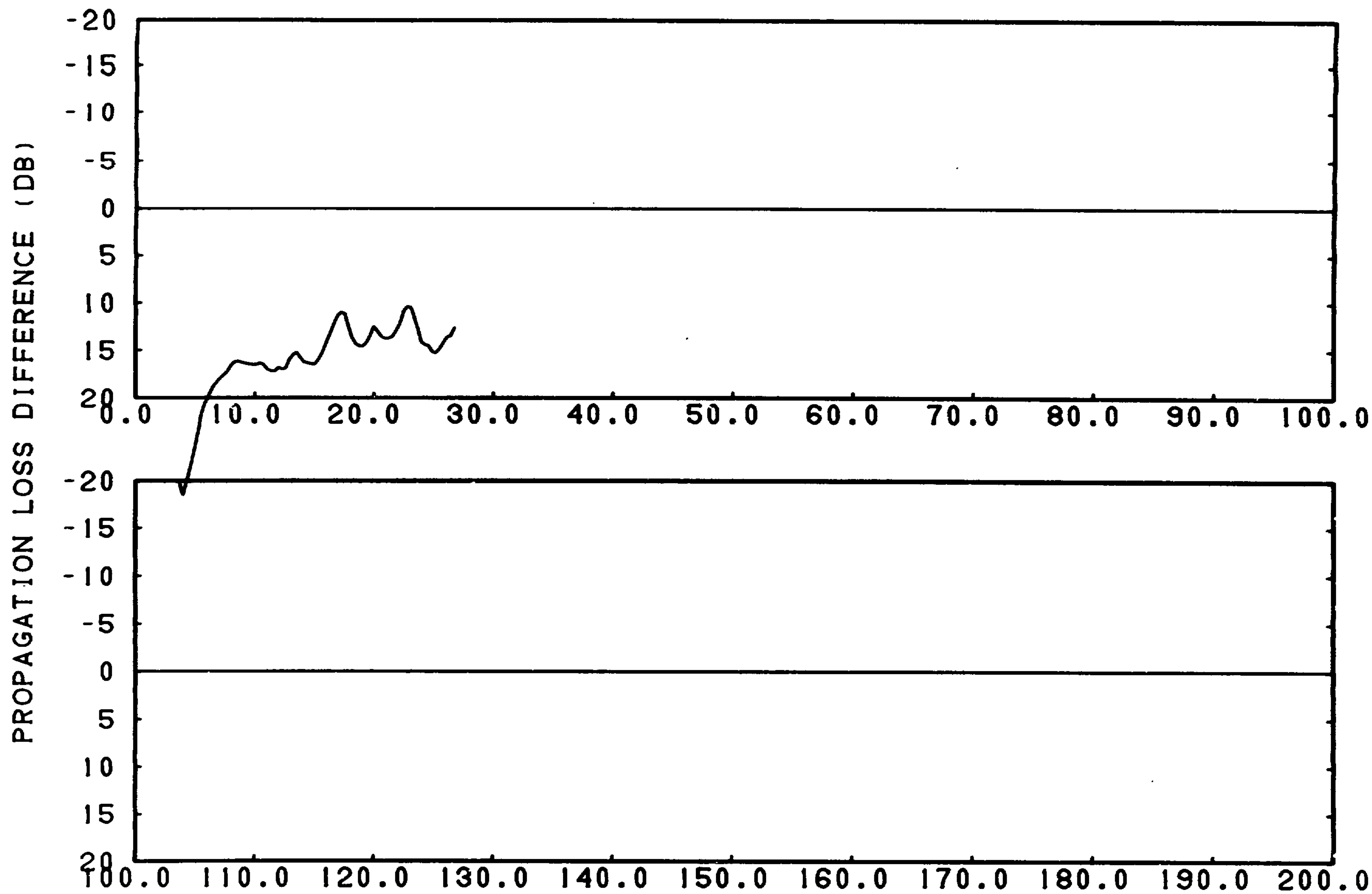
(C) Figure IIH-76. FACT Incoherent, Run 108, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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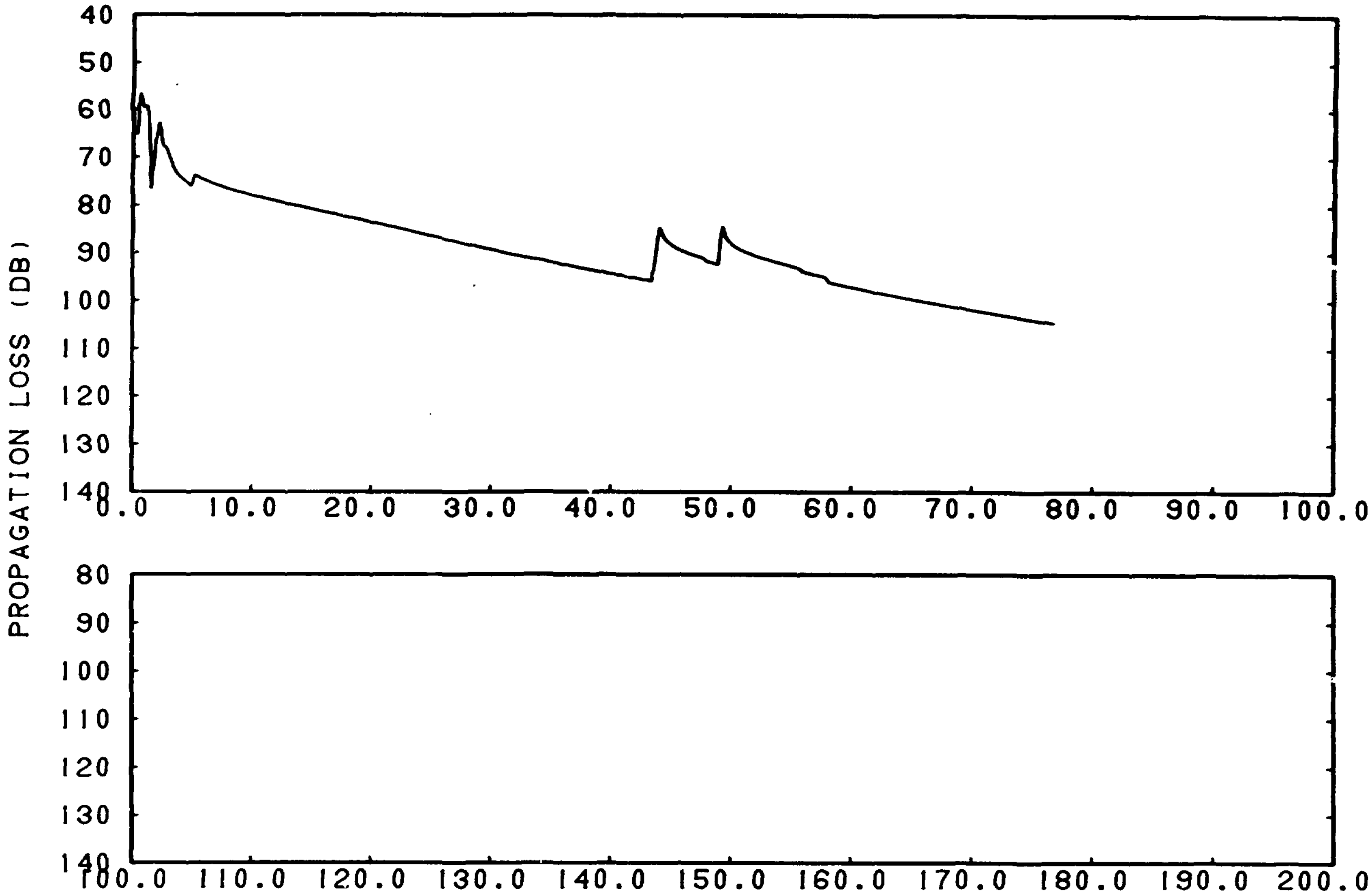
(C) Figure IIH-77. FACT Incoherent, Run 108, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 108, Source Depth = 1067 Meters, Receiver D th = 30.5 Meters, Frequency = 2.5 Kilohertz



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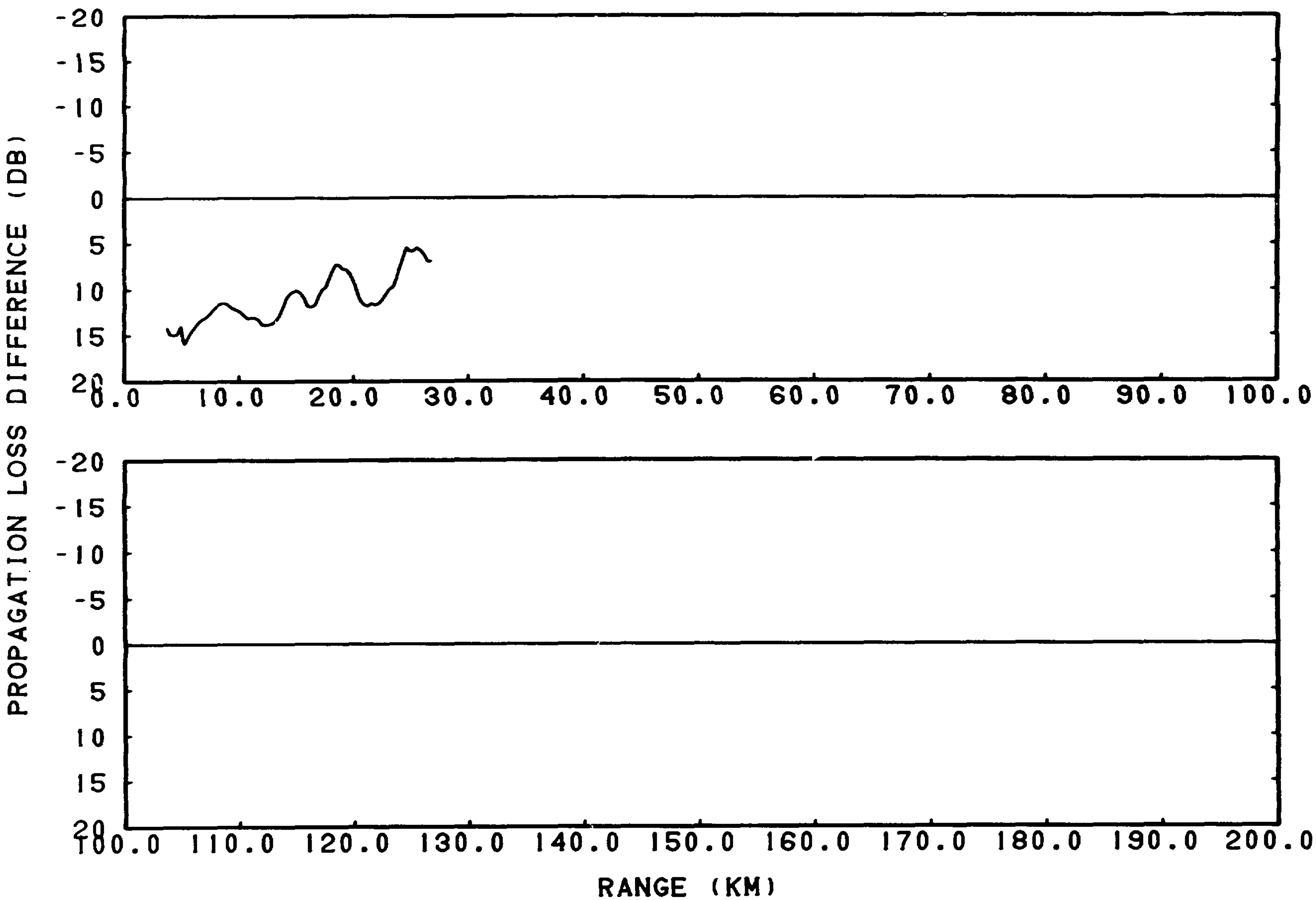
(C) Figure IIH-78, FACT Coherent, Run 108, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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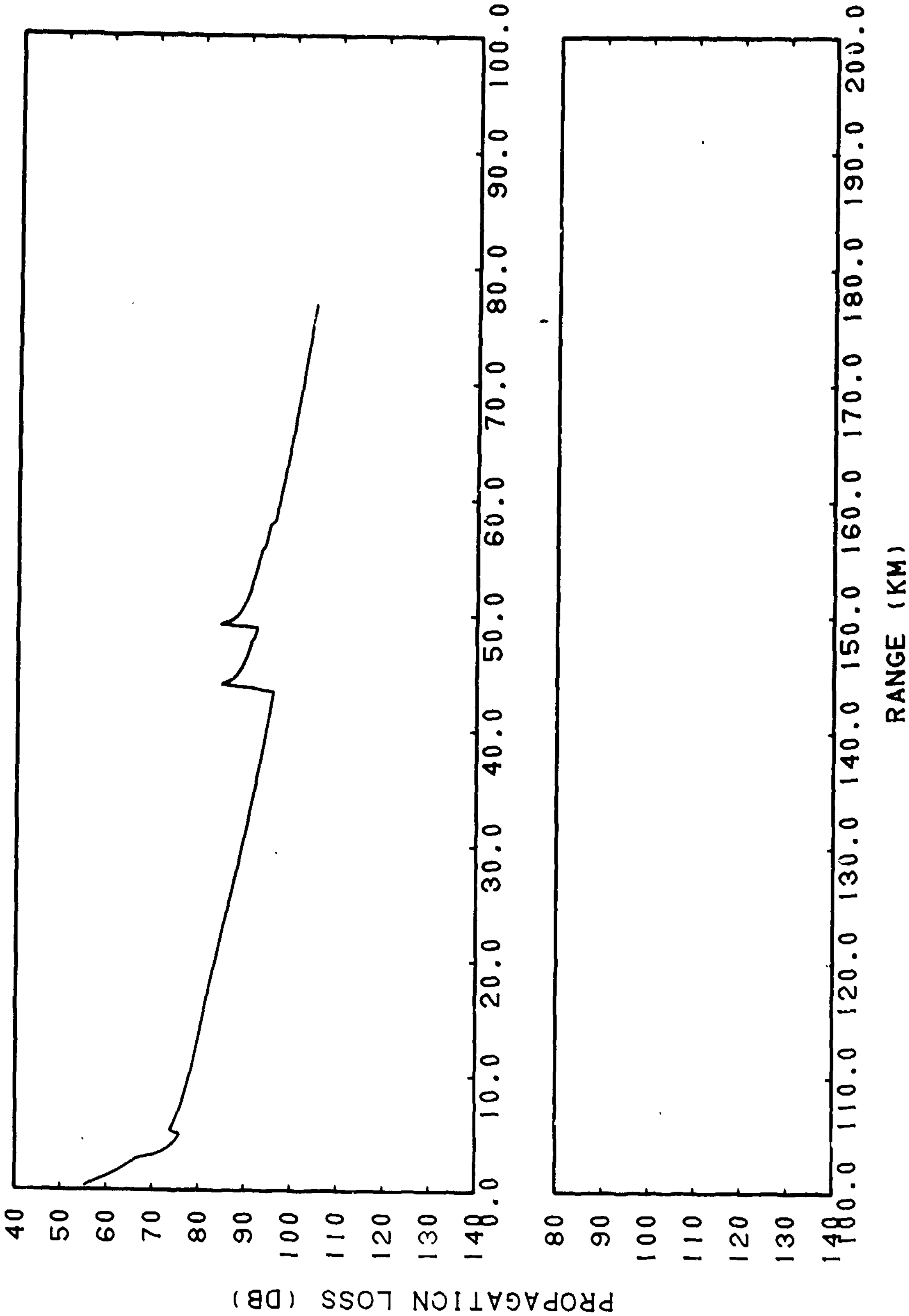
(C) Figure IIH-79. FACT Coherent, Run 108, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 108, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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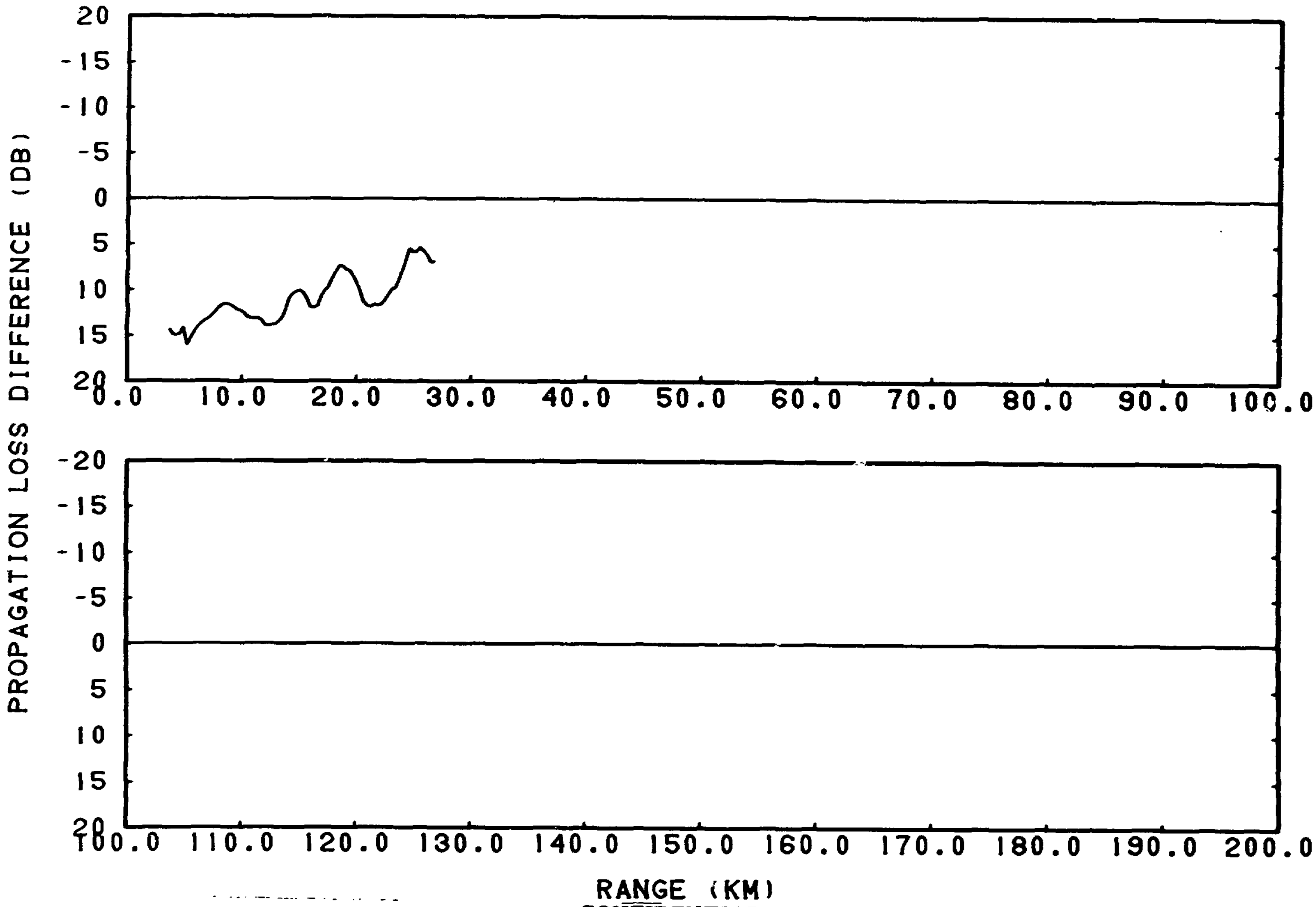
(C) Figure IIH-80. FACT Semi-coherent, Run 108, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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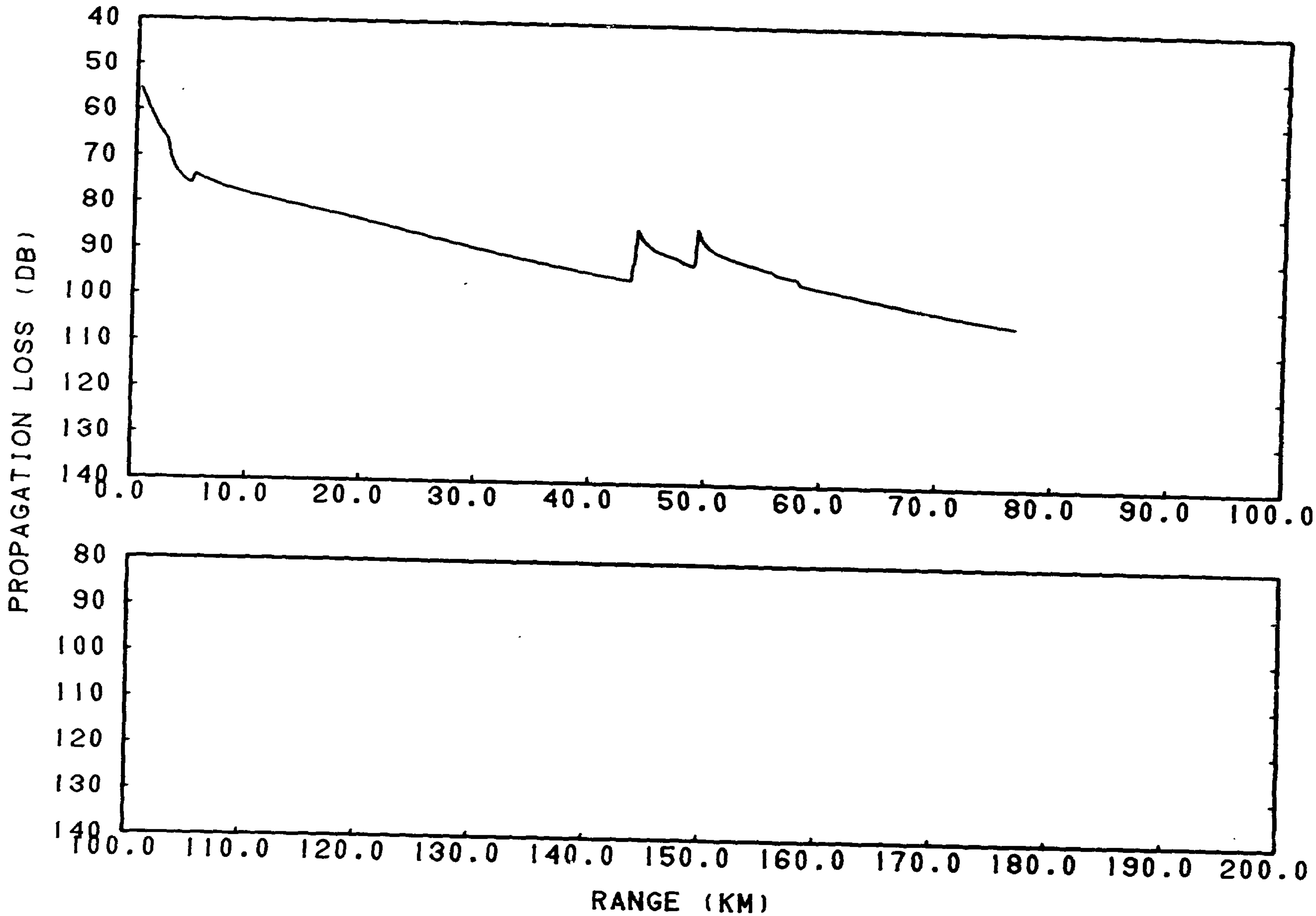
(C) Figure IIH-81. FACT Semi-coherent, Run 108, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 108, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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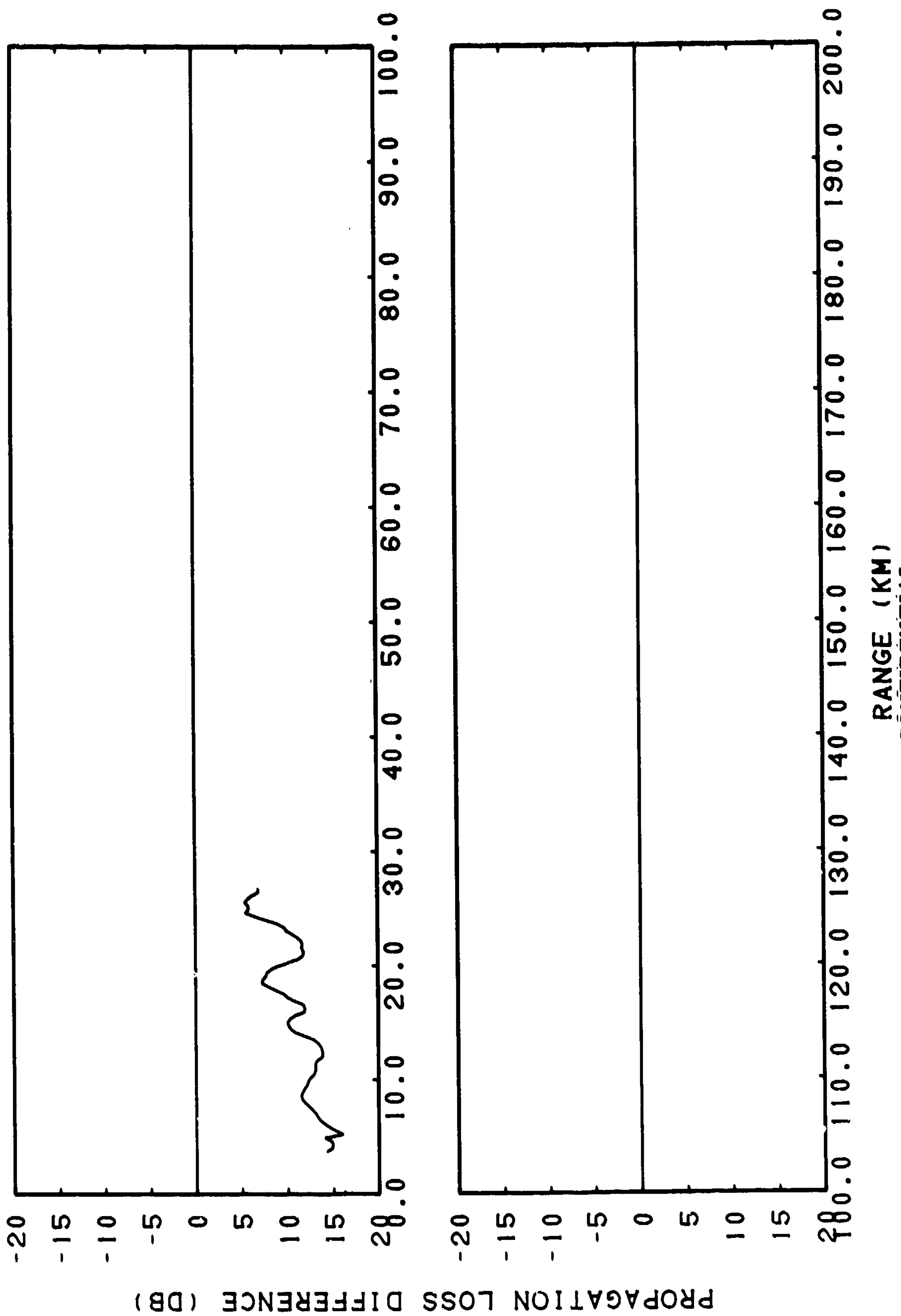
(C) Figure IIH-82. FACT Incoherent, Run 108, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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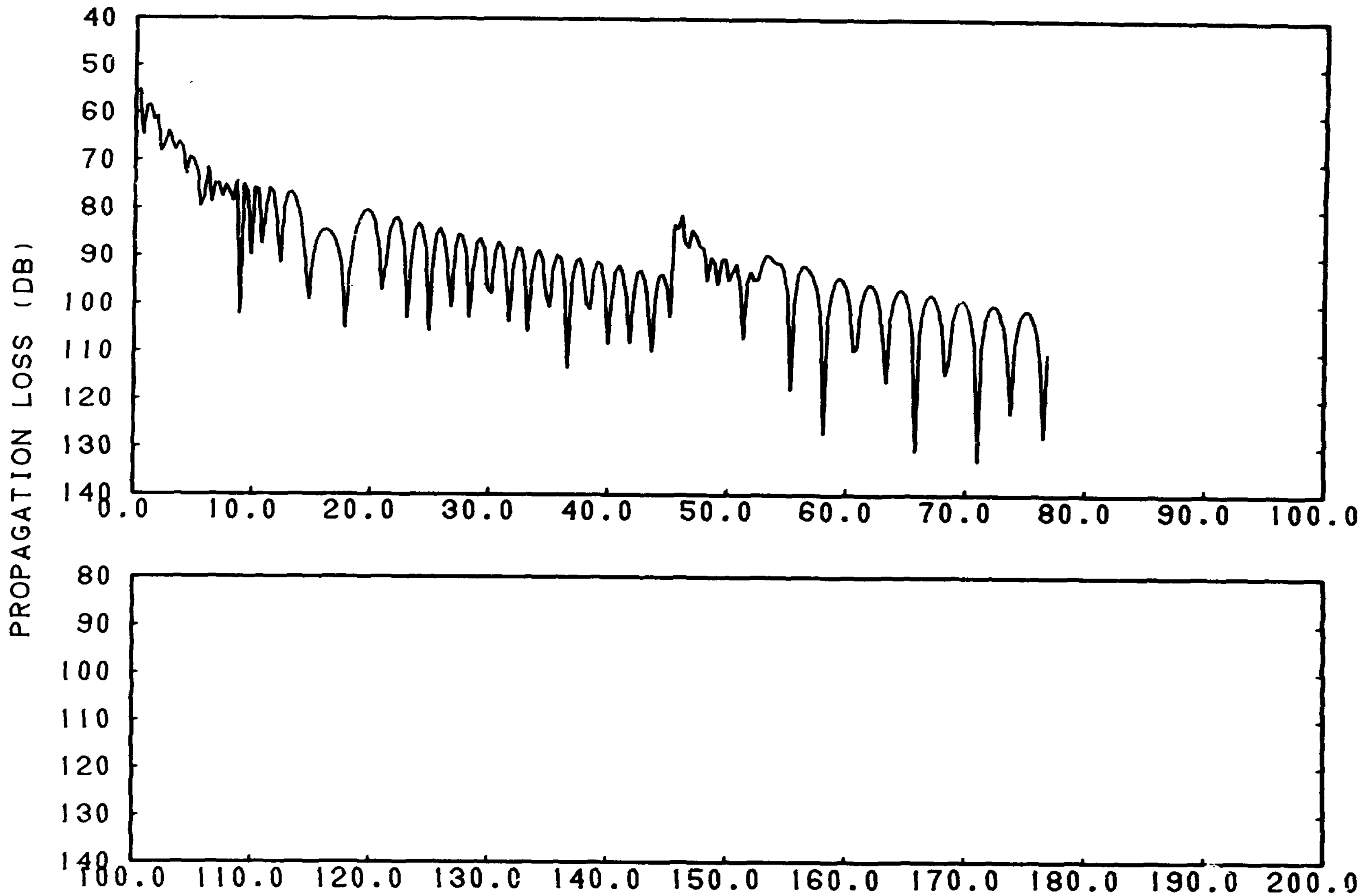
(C) Figure IIH-83. FACT Incoherent, Run 108, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 108, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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(C) Figure IIH-84. FACT Coherent, Run 107, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz

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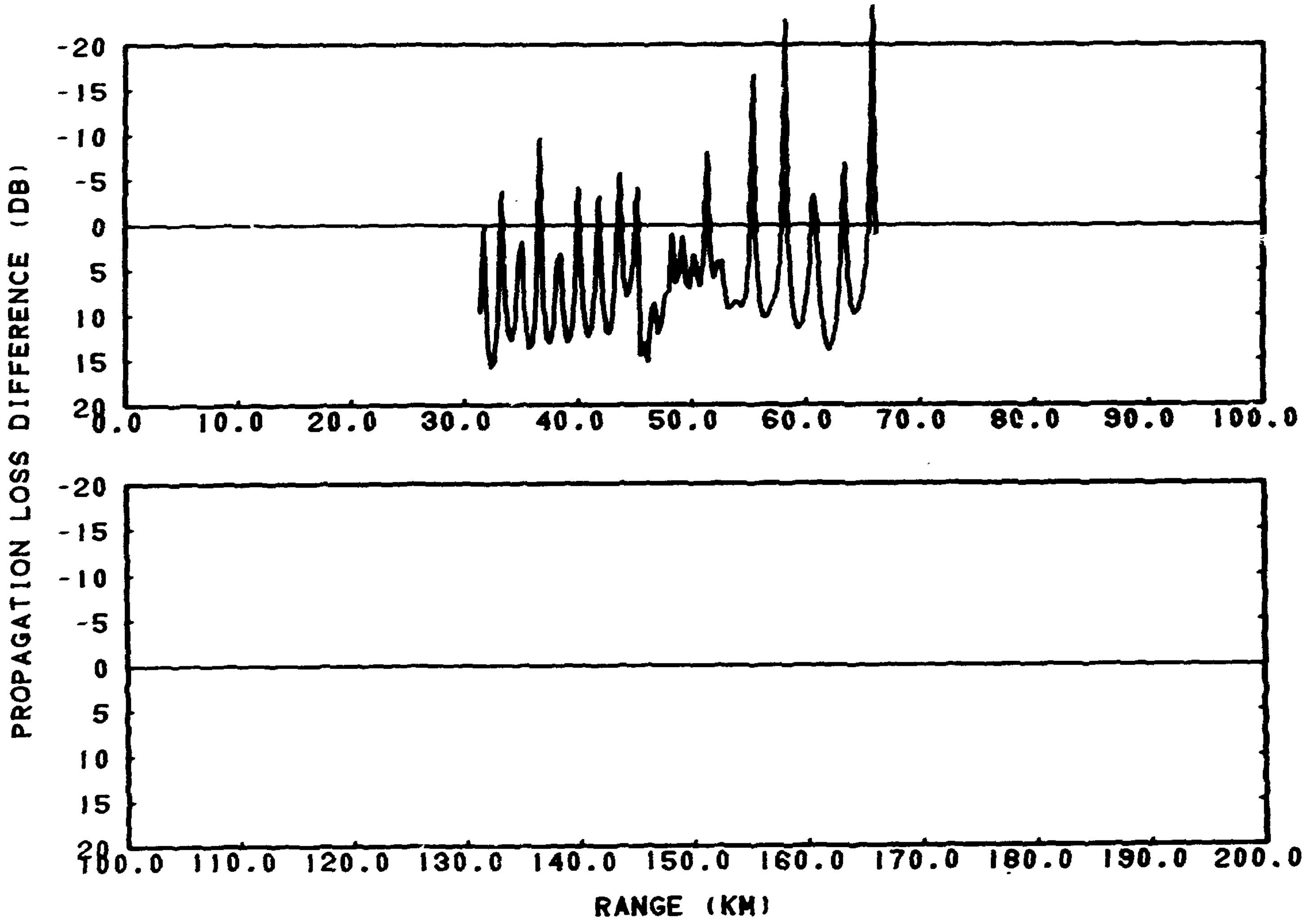

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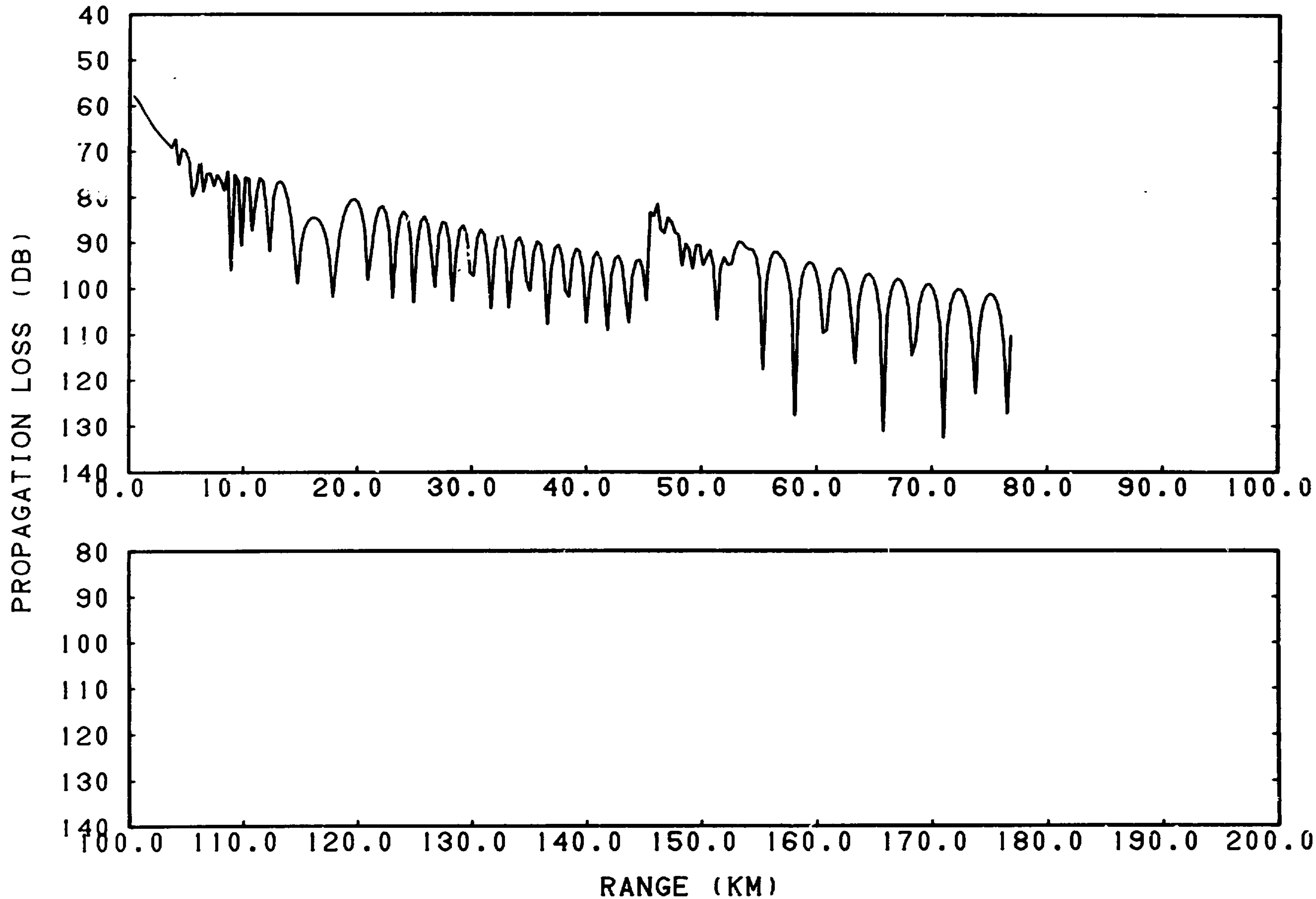
(C) Figure IIH-85. FACT Coherent, Run 107, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 107, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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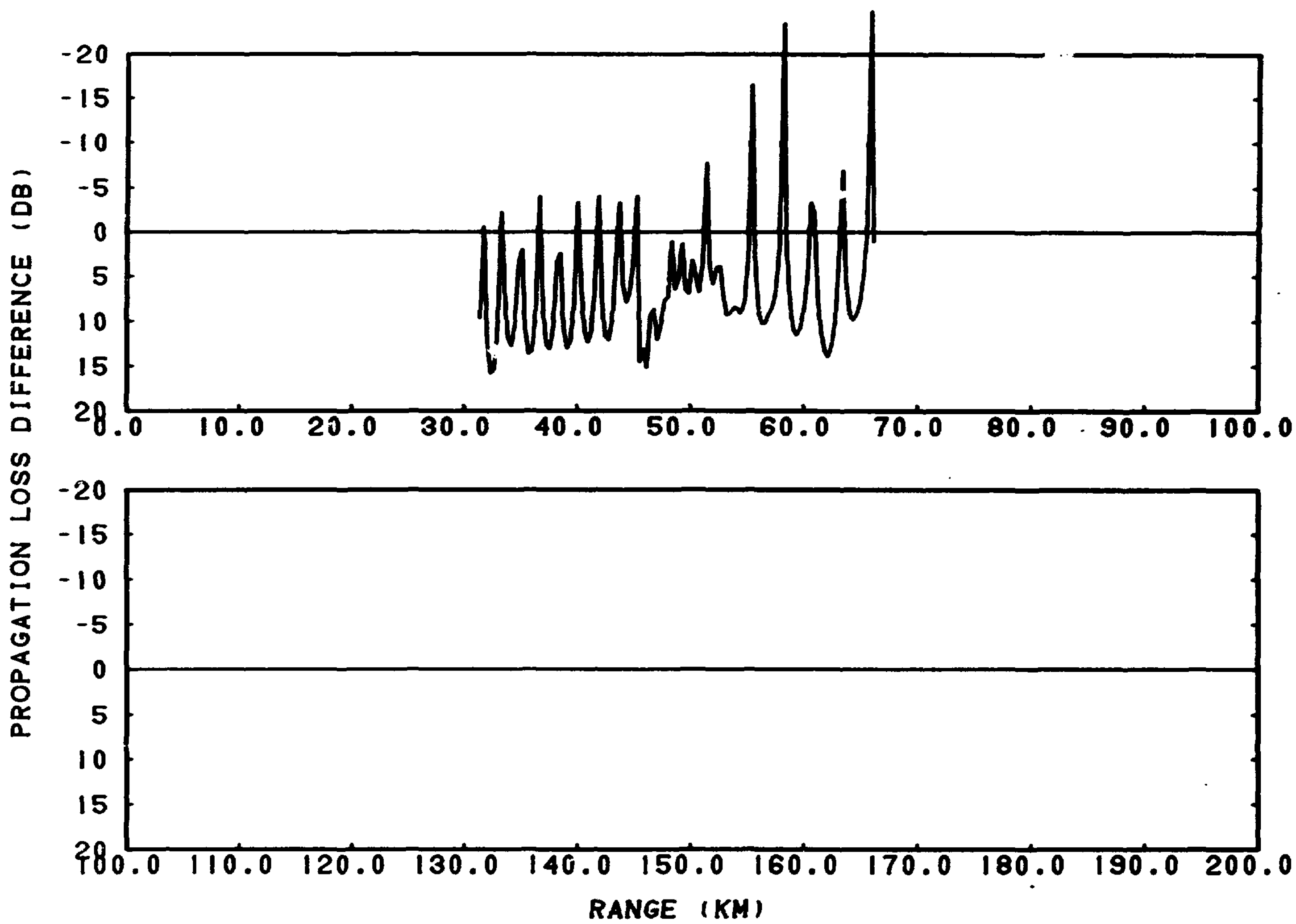
(C) Figure IIH-86. FACT Semi-coherent, Run 107, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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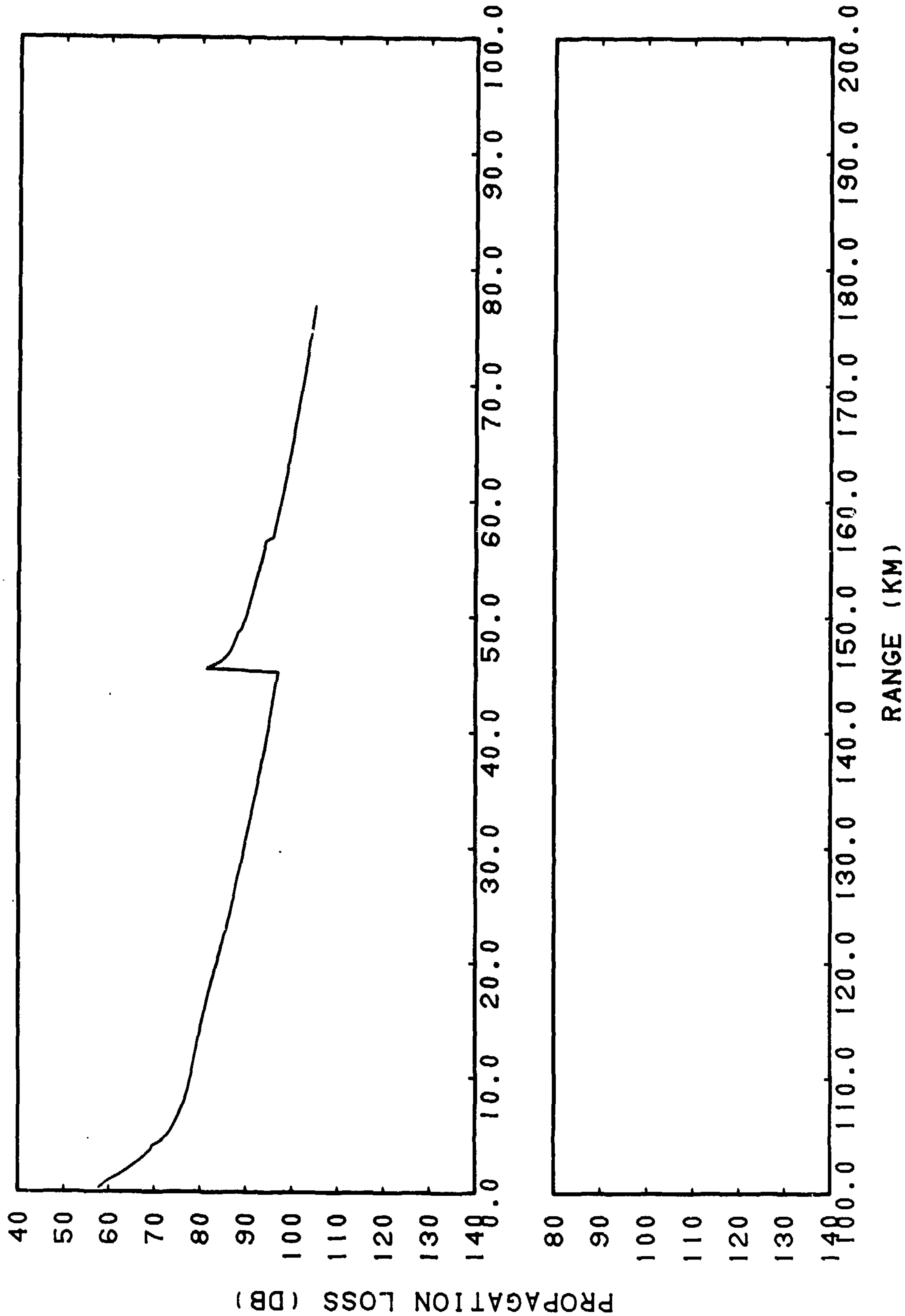
(C) Figure IIH-87. FACT Semi-coherent, Run 107, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 107, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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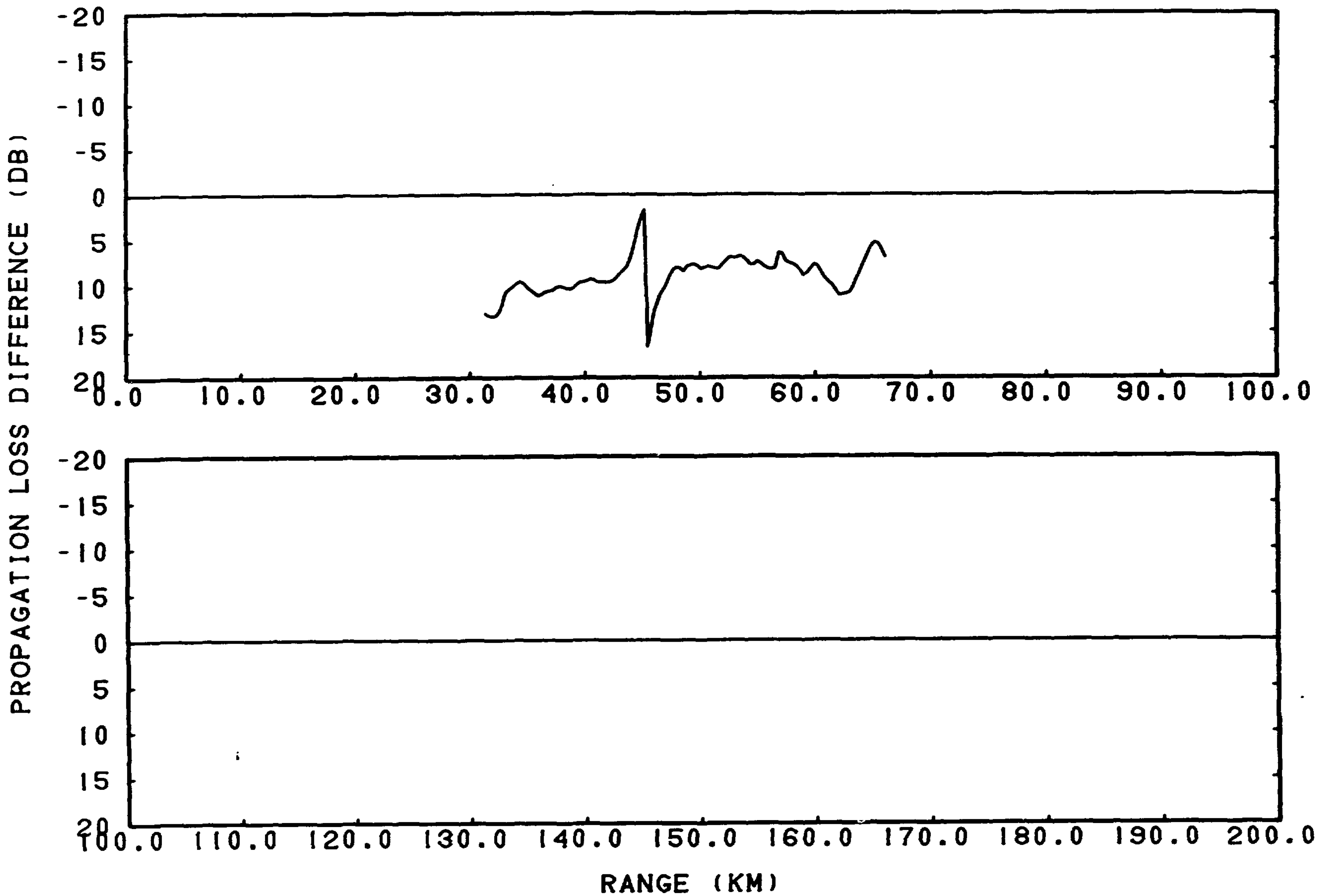
(C) Figure IIH-88. FACT Incoherent, Run 107, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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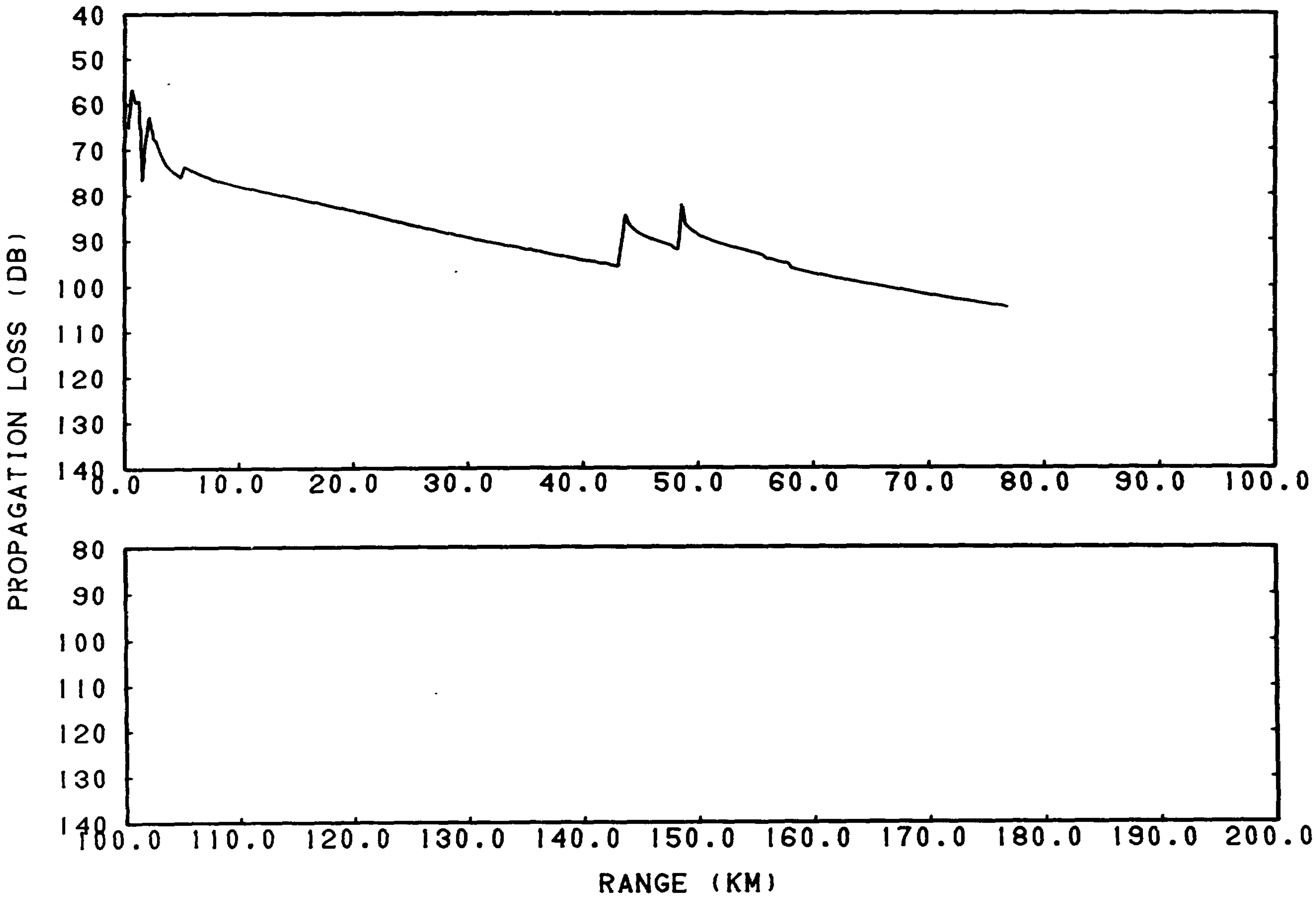
(C) Figure IIH-89. FACT Incoherent, Run 107, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 107, Source Depth = 1067 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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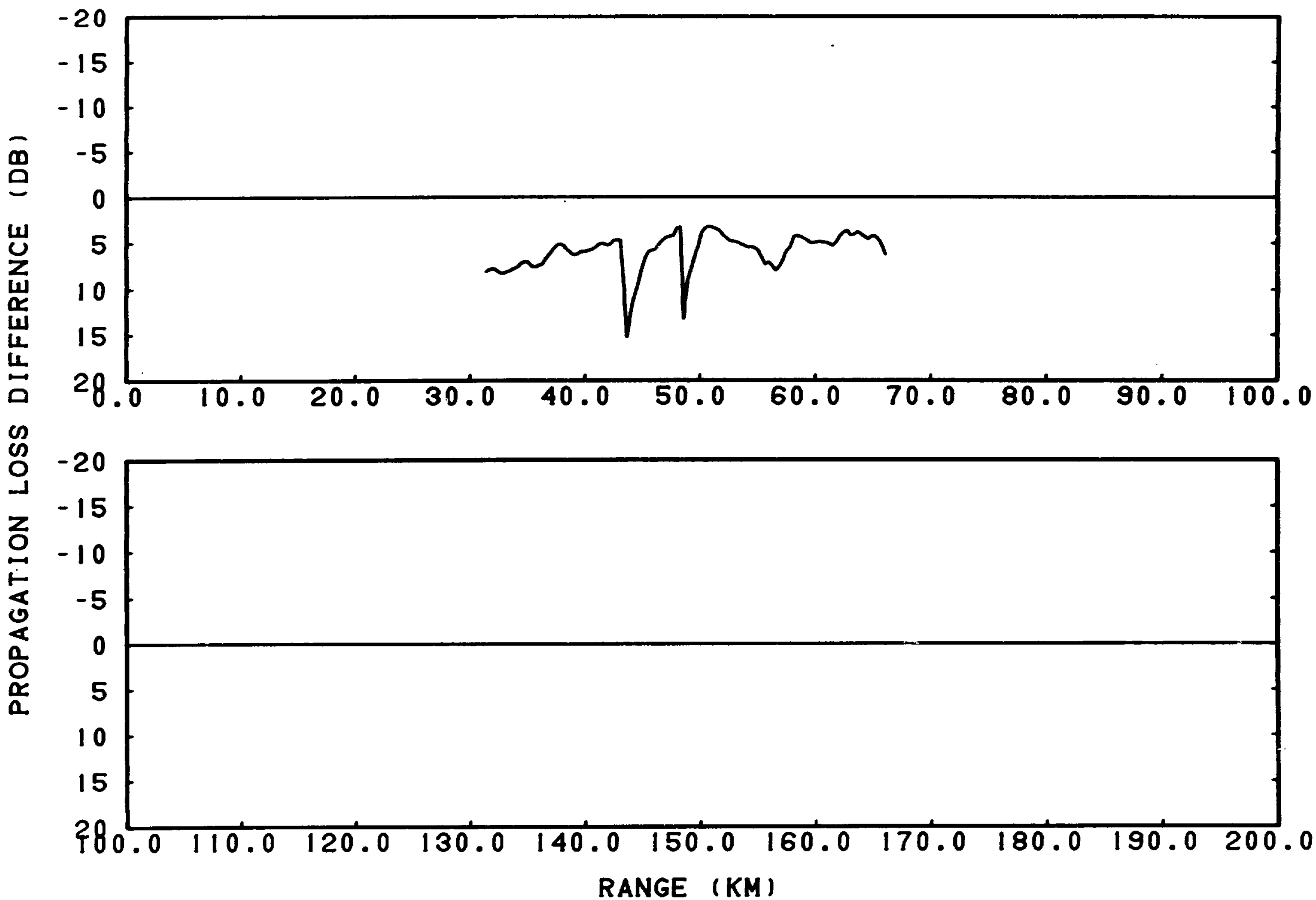
(C) Figure IIH-90. FACT Coherent, Run 107, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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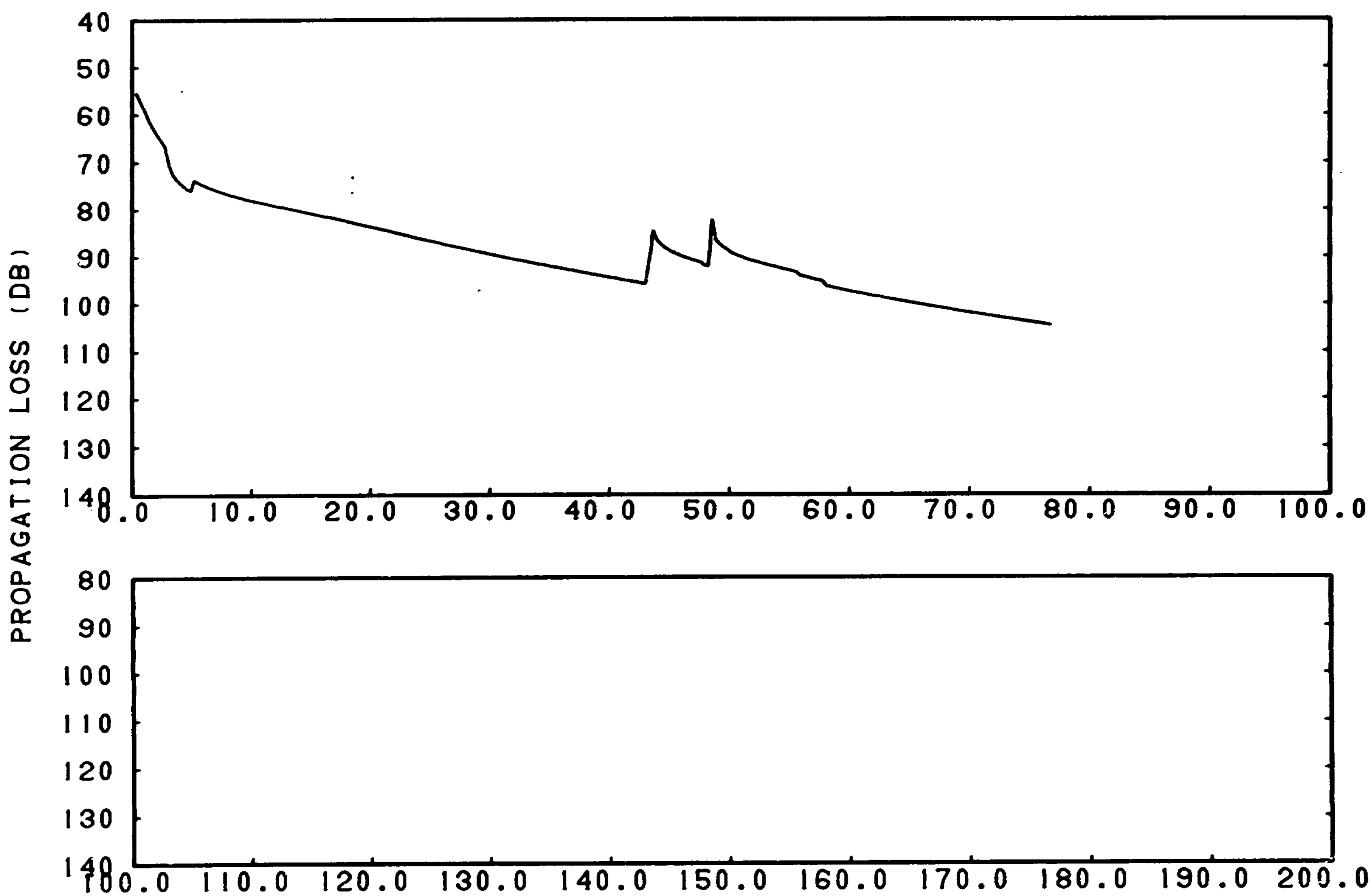
(C) Figure IIH-91. FACT Coherent, Run 107, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 107, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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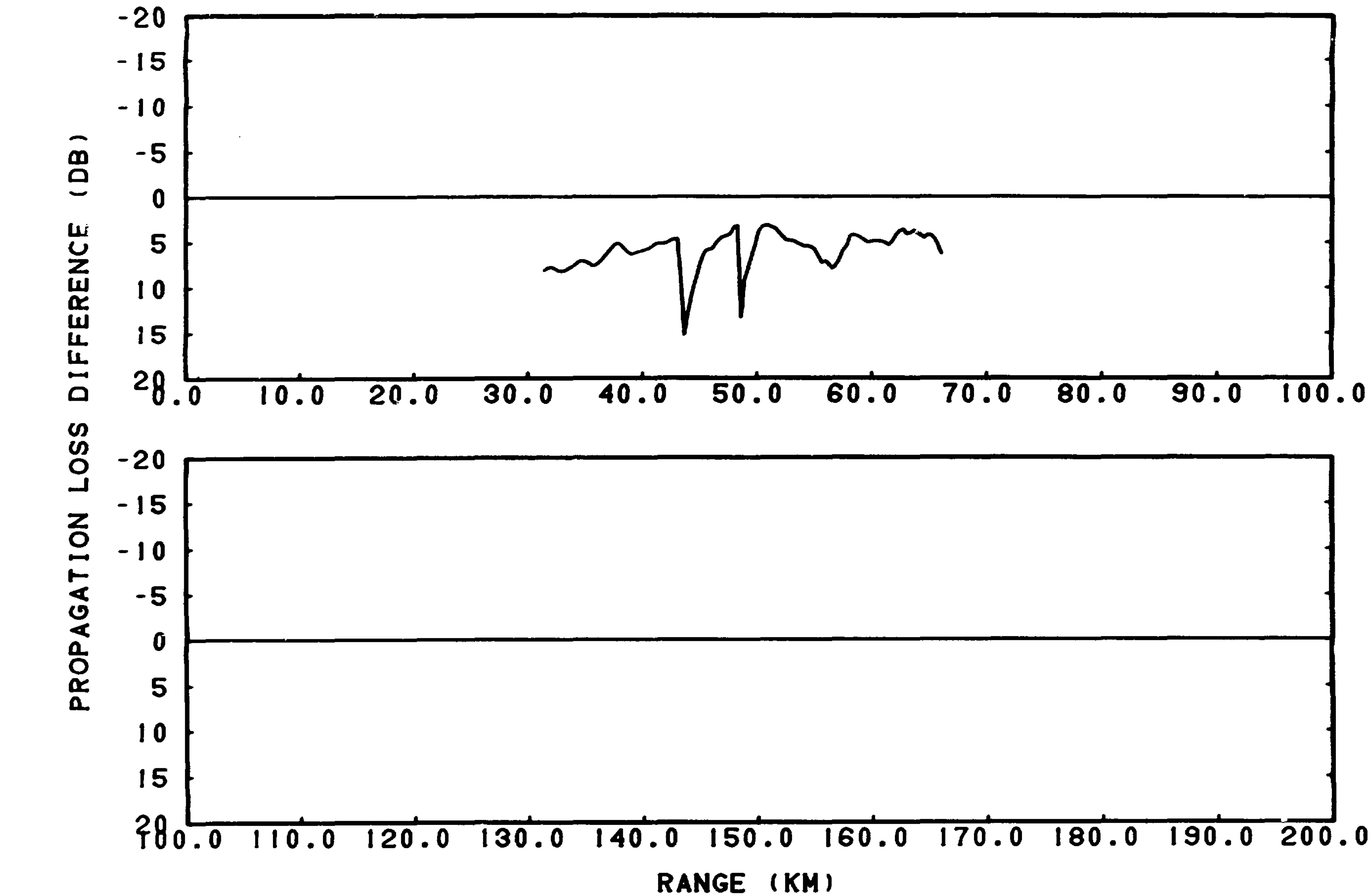
(C) Figure IIH-92. FACT Semi-coherent, Run 107, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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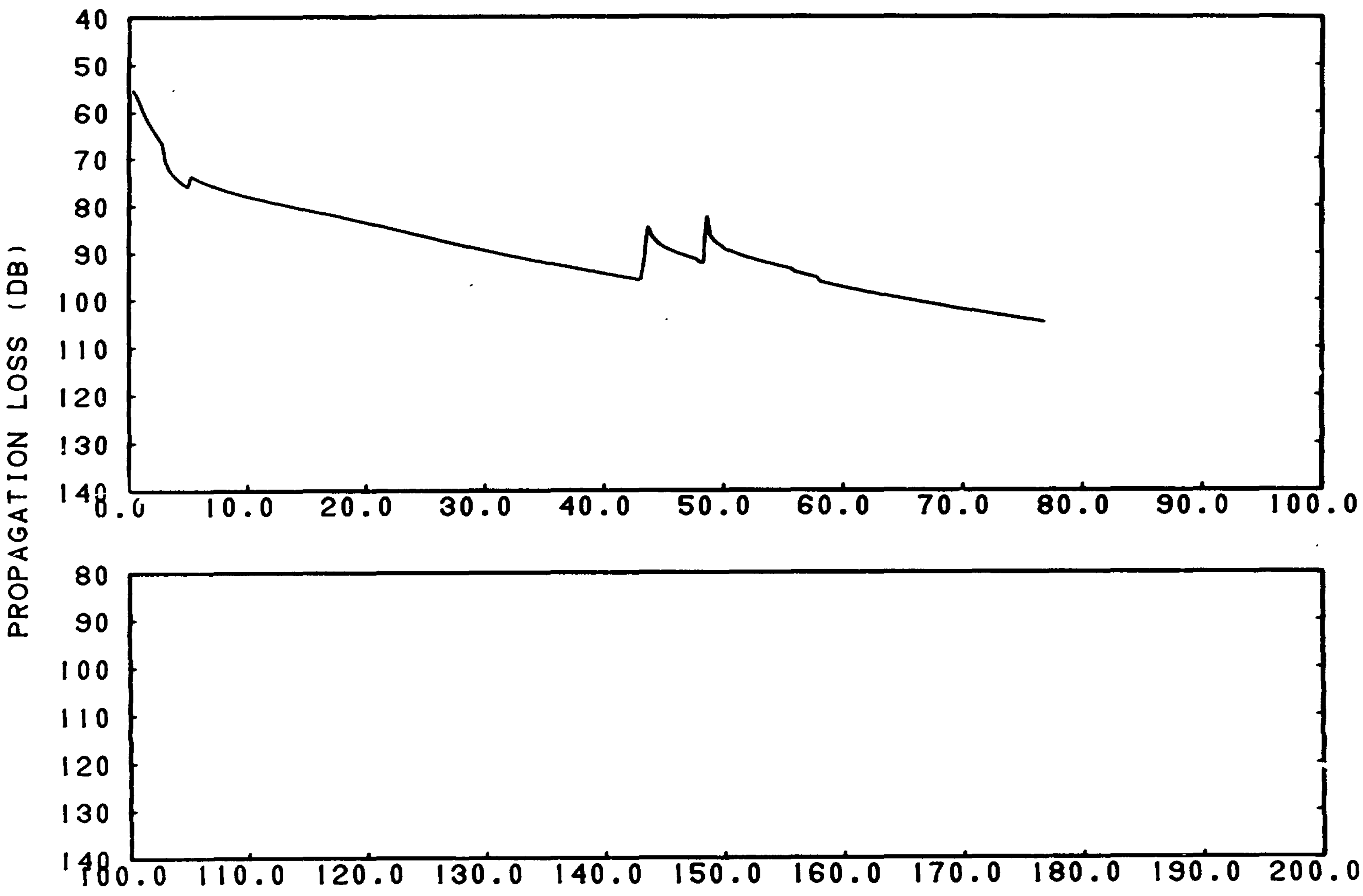
(C) Figure IIH-93. FACT Semi-coherent, Run 107, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 107, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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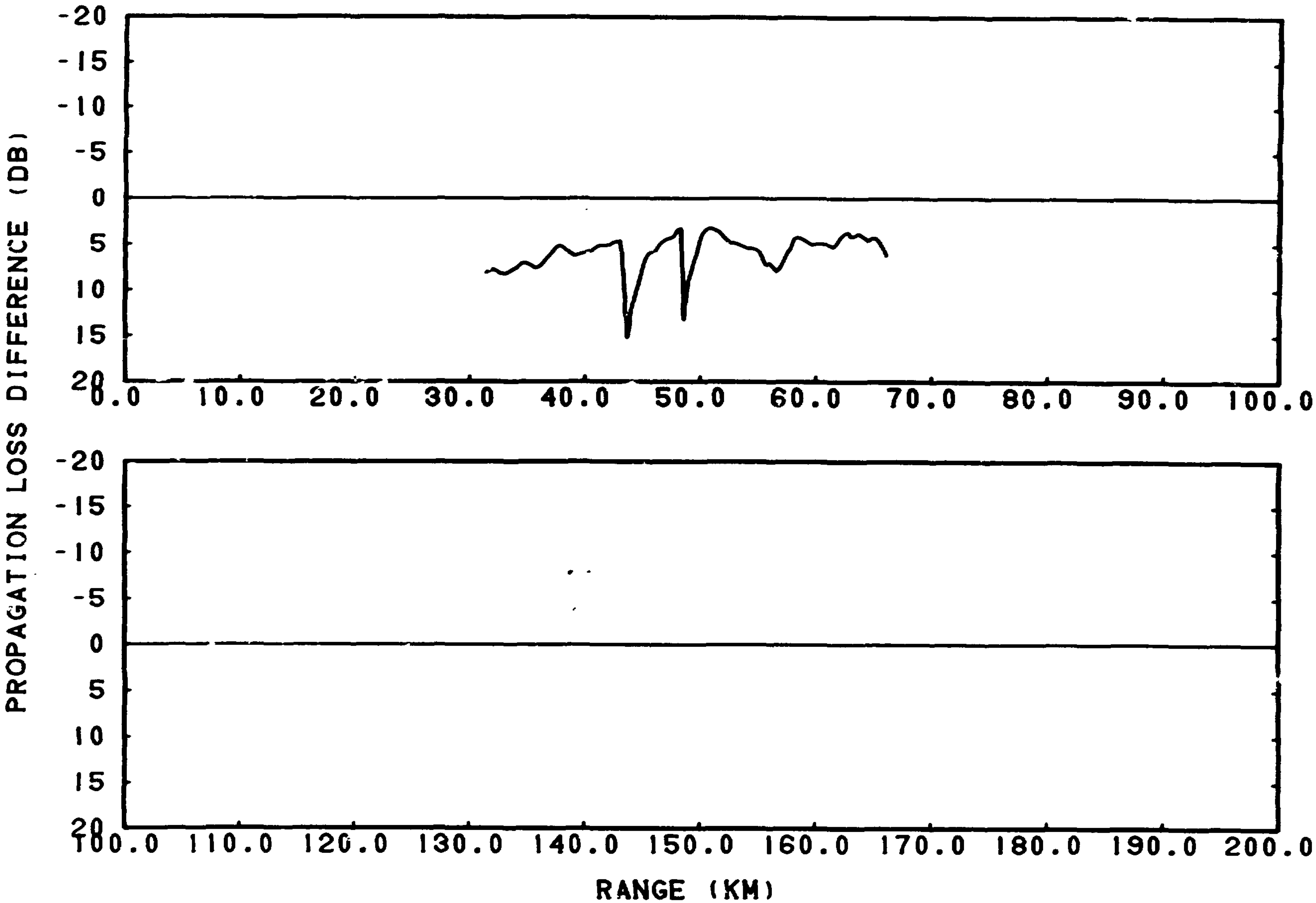
(C) Figure IIH-94. FACT Incoherent, Run 107, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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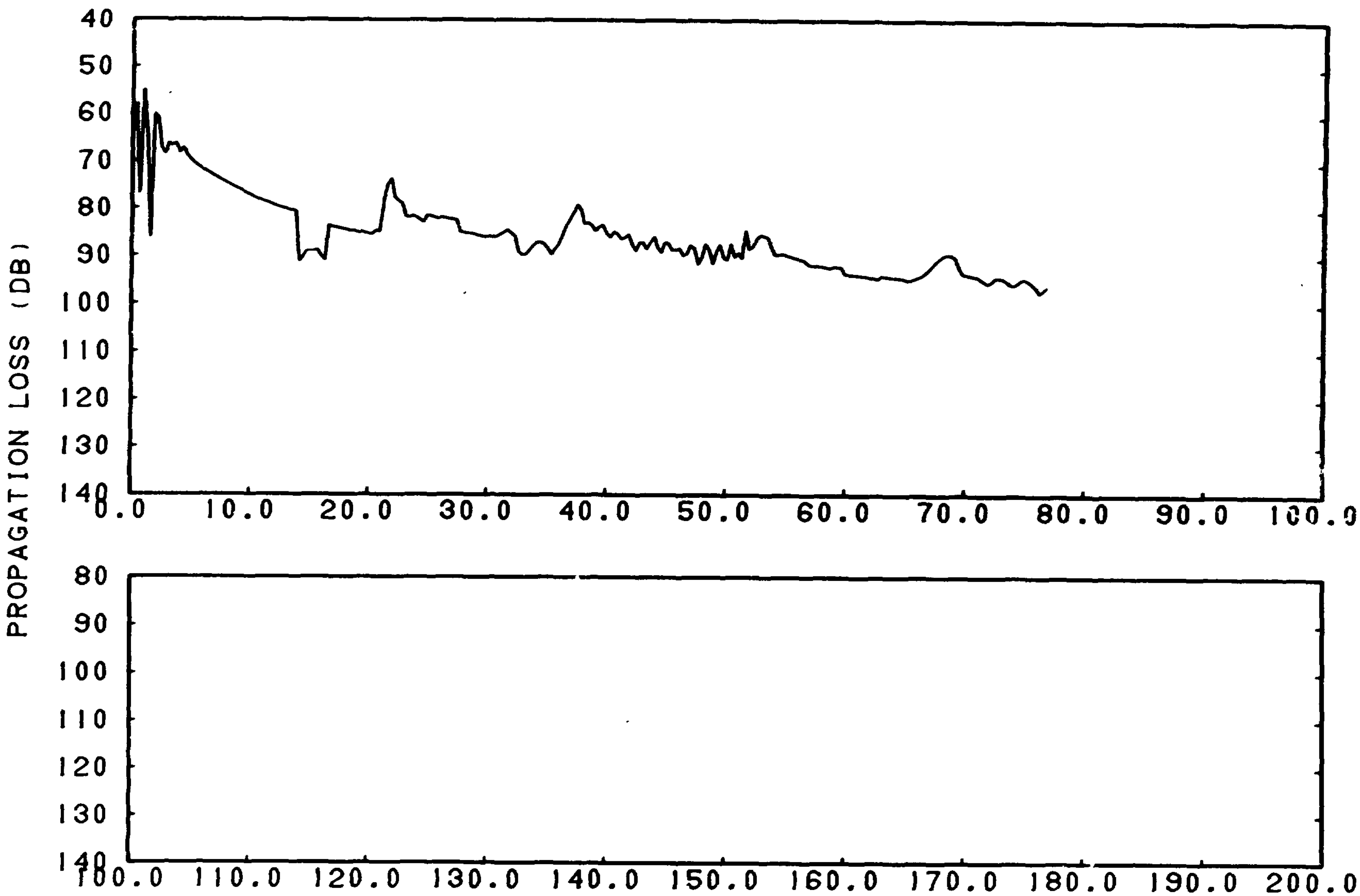
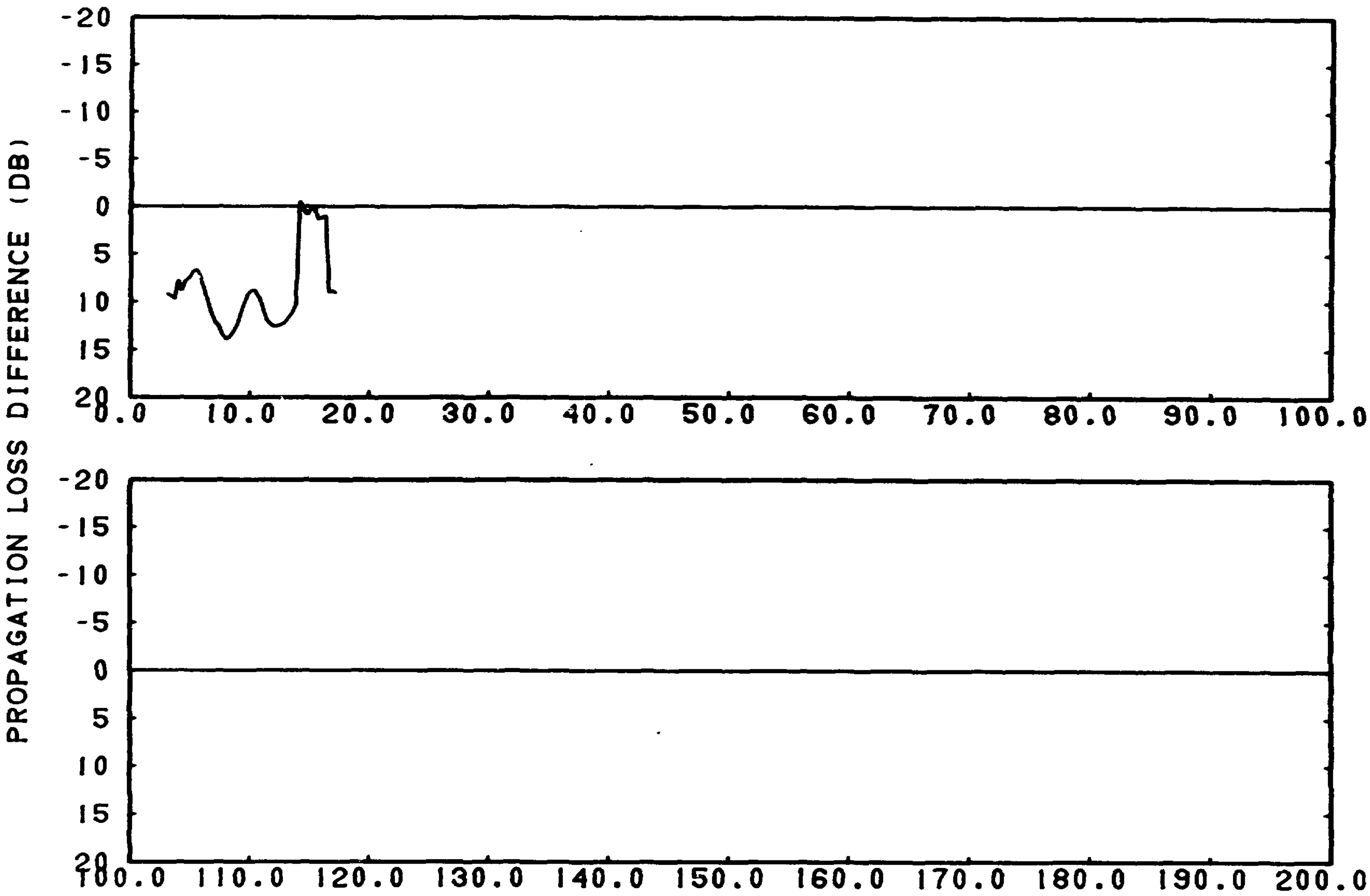
(C) Figure IIH-95. FACT Incoherent, Run 107, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz. Subtracted from Smoothed Gulf of Alaska, Run 107, Source Depth = 1067 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



CONFIDENTIAL

C) Figure IIH-96. FACT Coherent, Run 112B, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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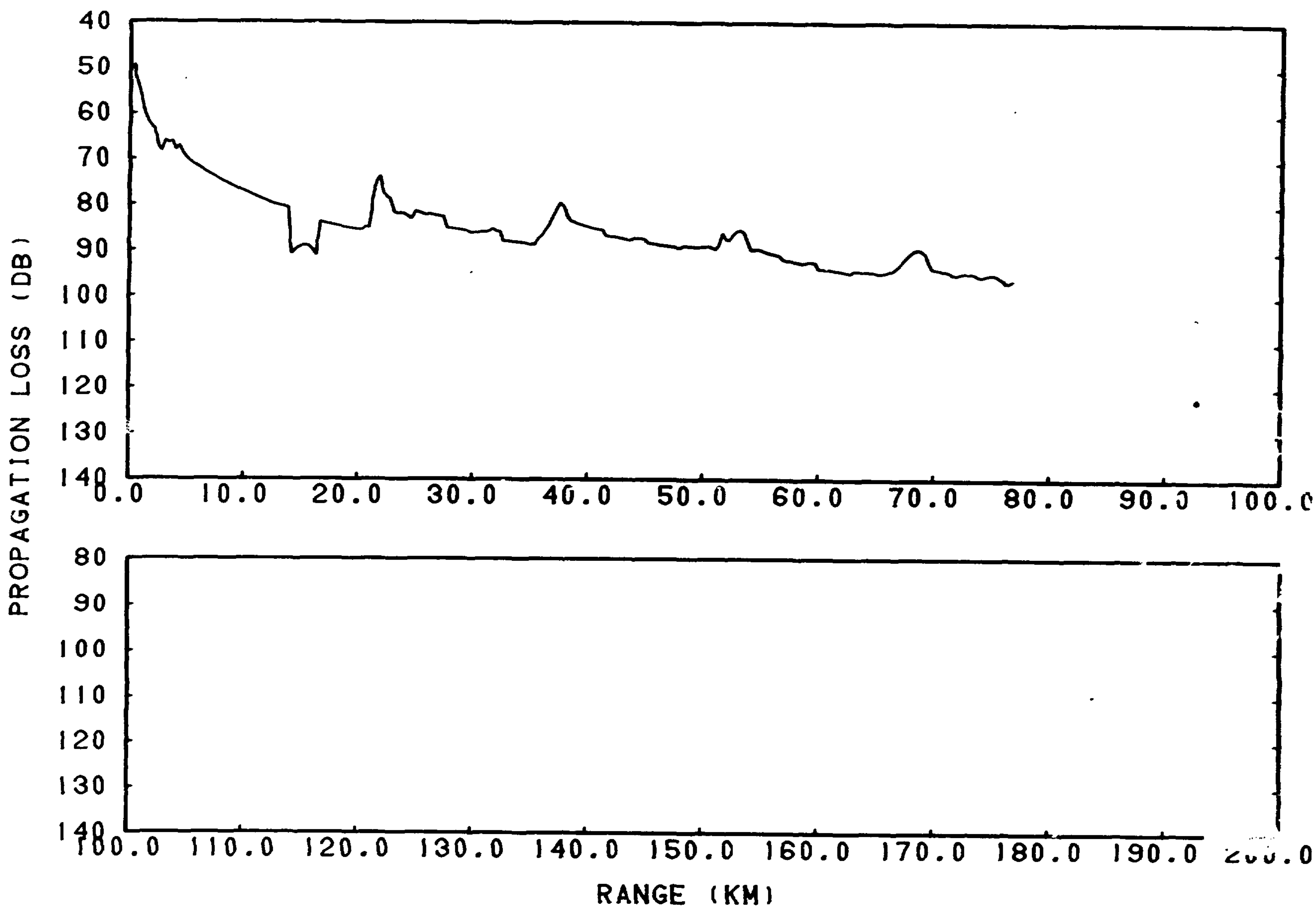
(C) Figure IIH-97. FACT Coherent, Run 112B, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 112B, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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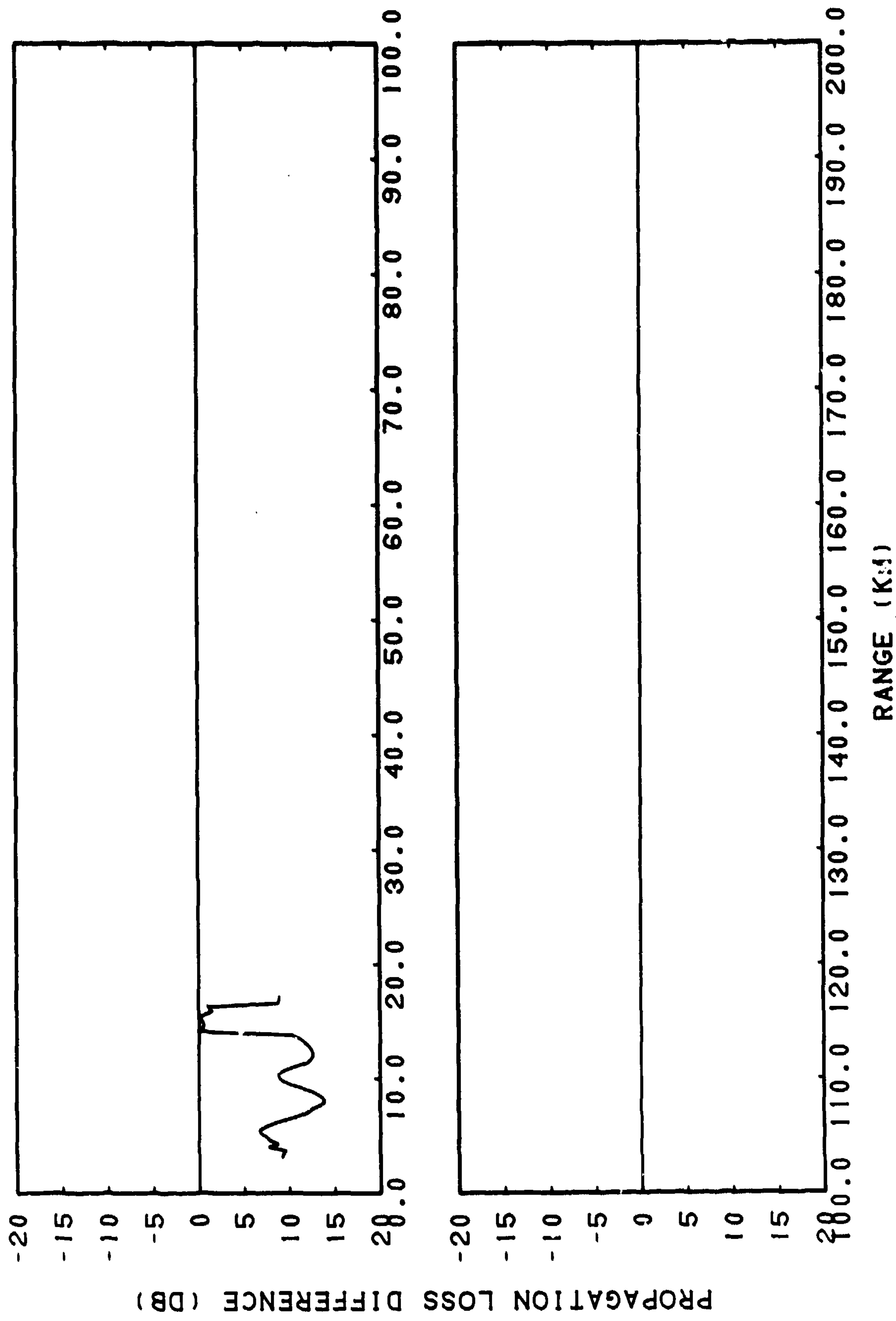
(C) Figure IIH-98. FACT Semi-coherent, Run 112 B, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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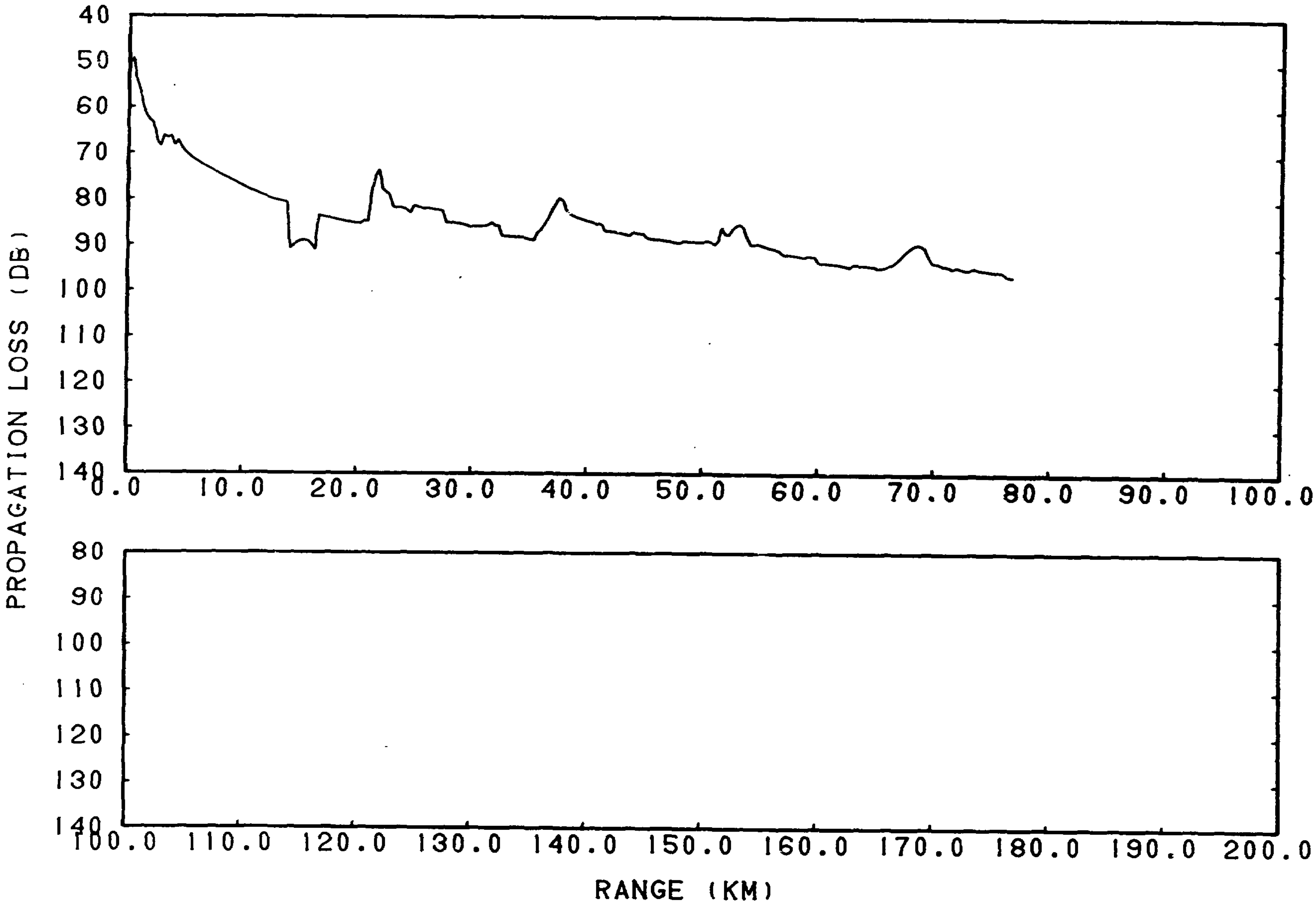
(C) Figure IIH-99. FACT Semi-coherent, Run 112B, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 112B, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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(C) Figure IIH-100. FACT Incoherent, Run 112B, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz

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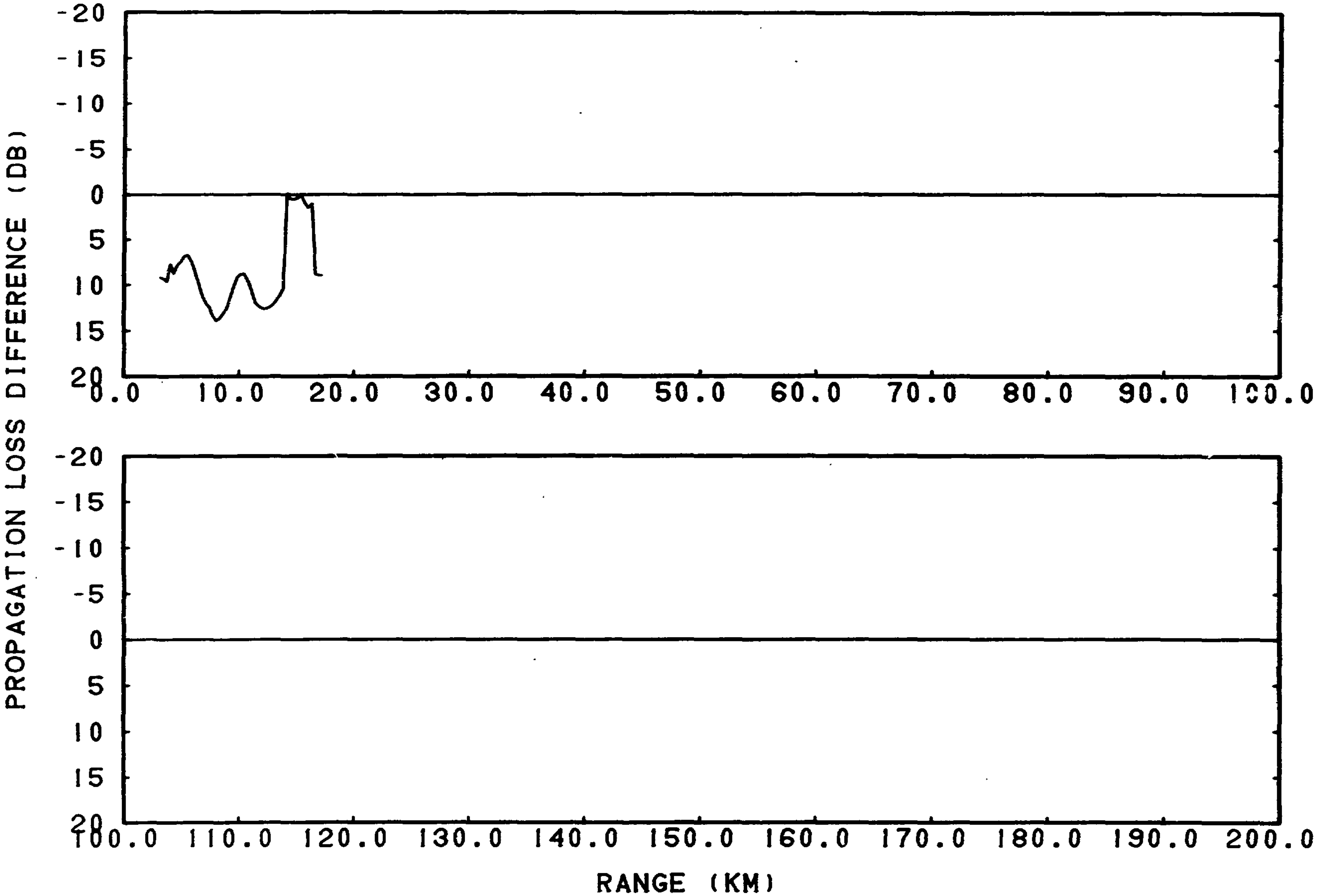

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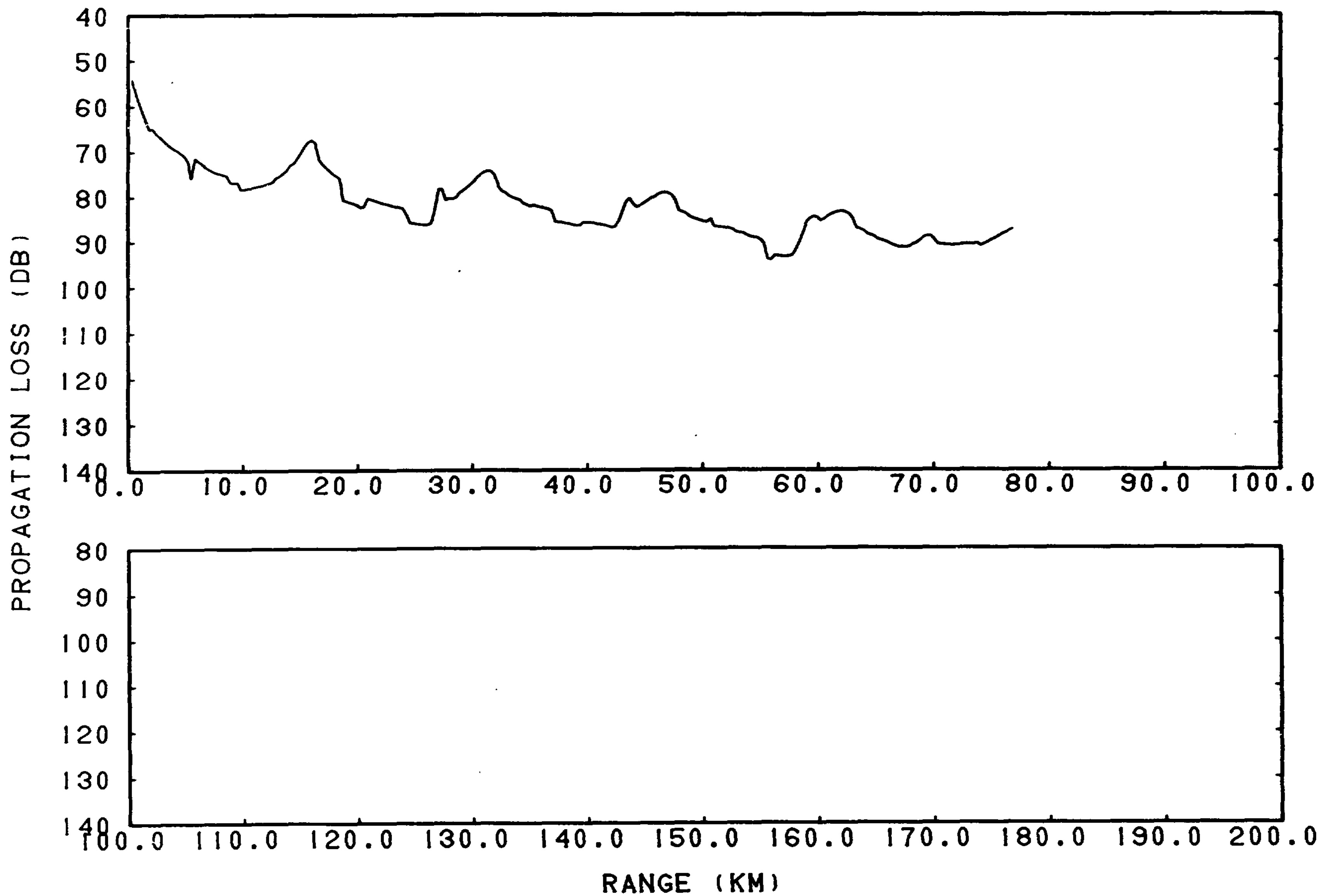
(C) Figure IIH-101. FACT Incoherent, Run 112B, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 112B, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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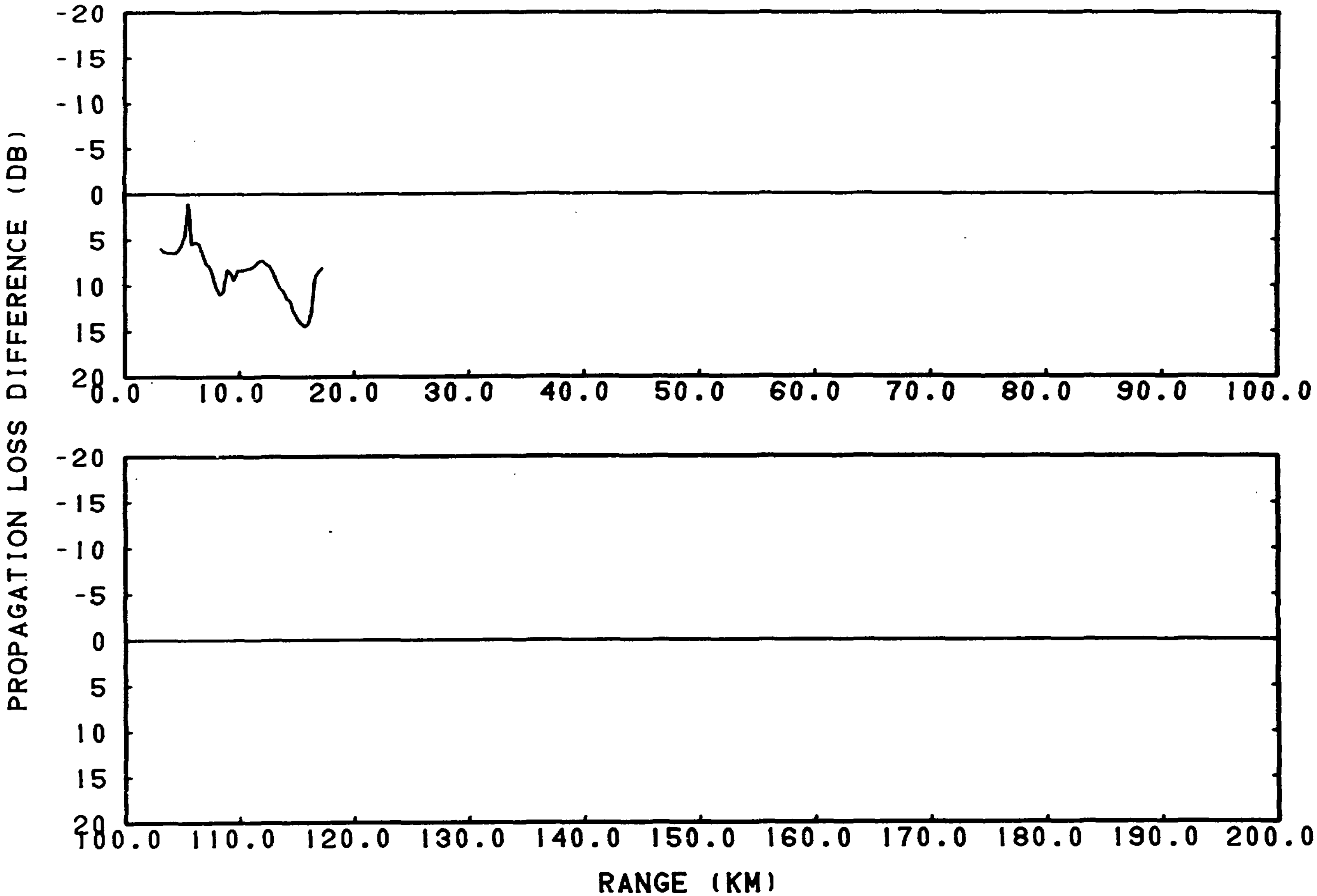
(C) Figure IIH-102. FACT Coherent, Run 112B, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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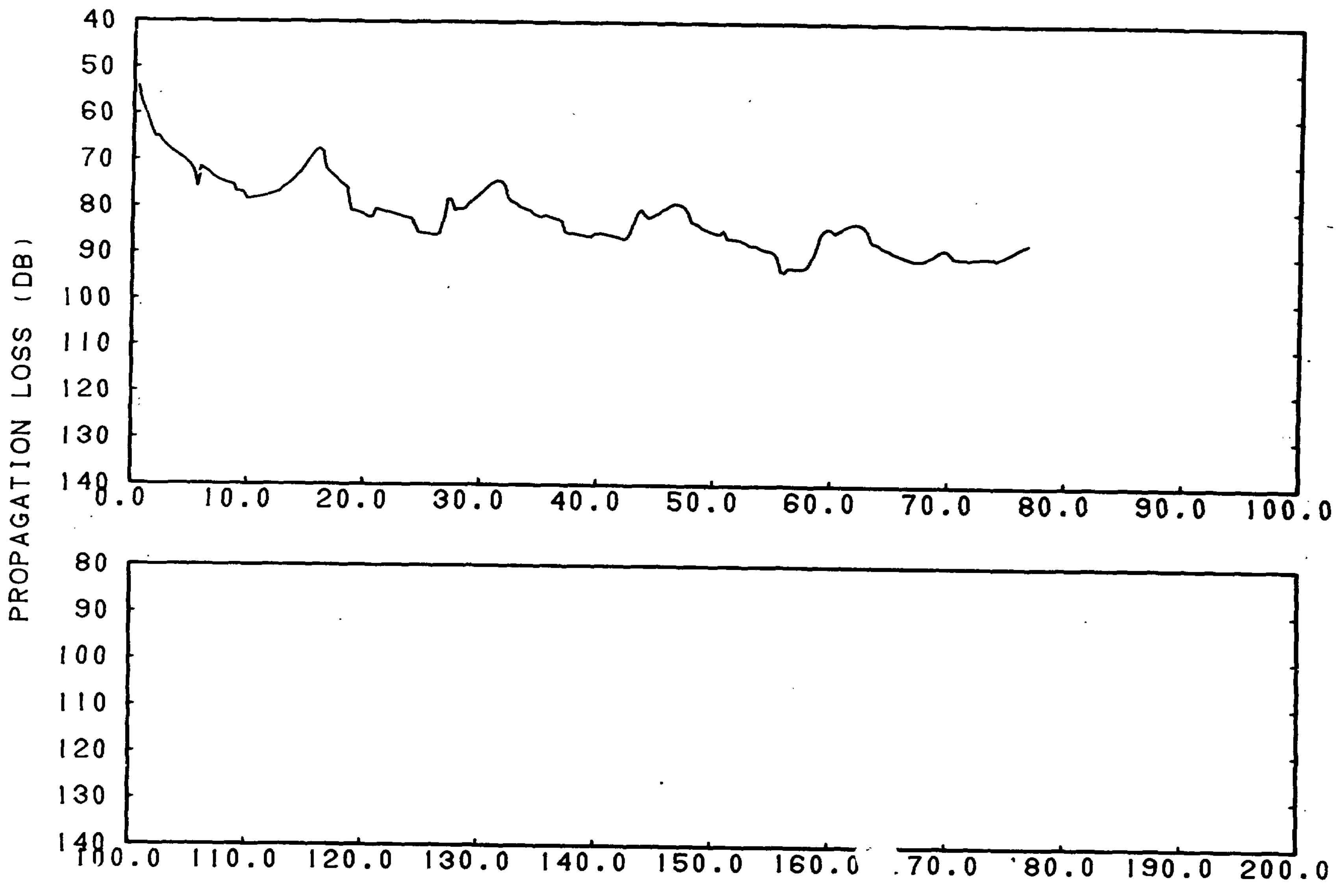
(C) Figure IIH-103. FACT Coherent, Run 112B, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 112B, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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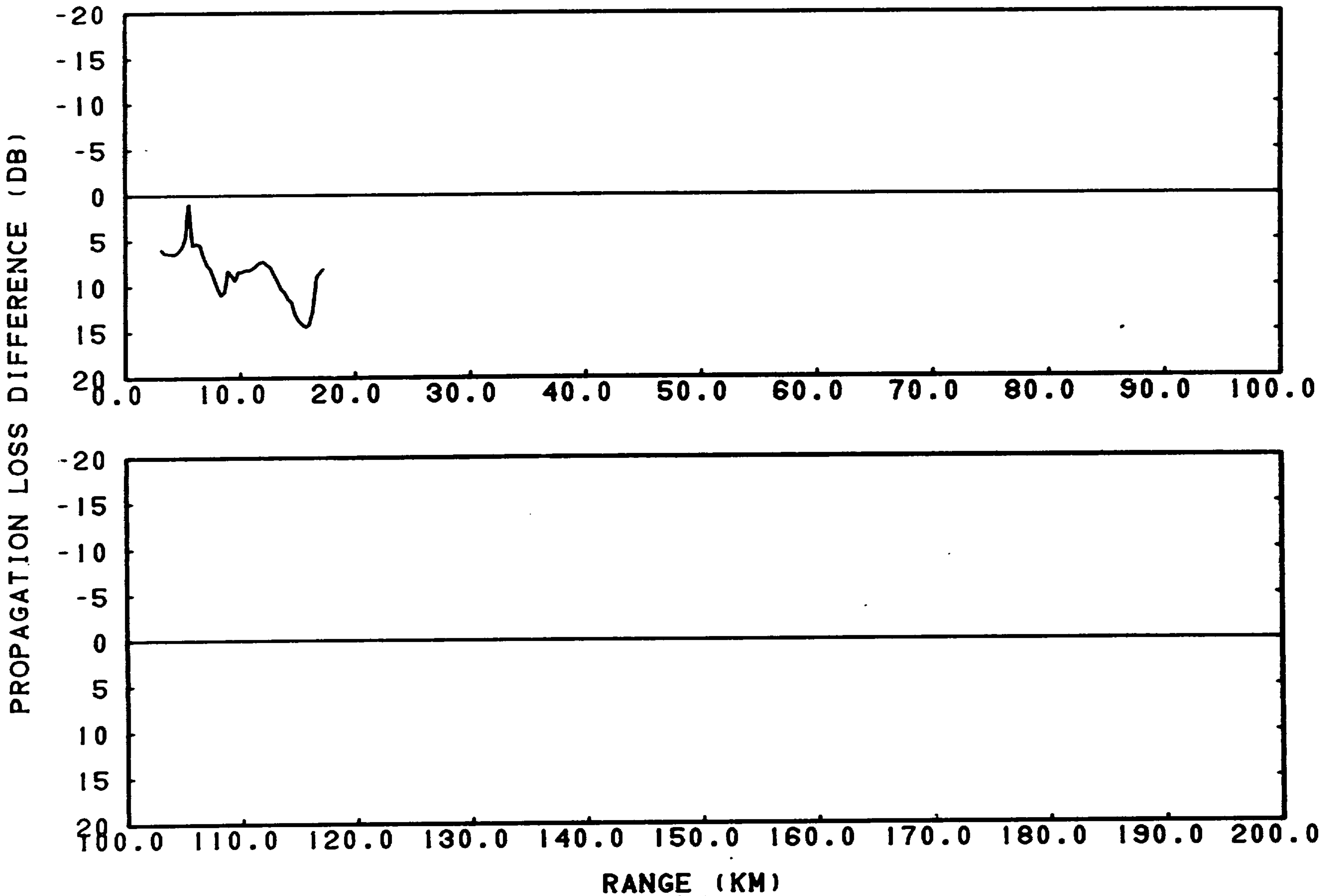
(C) Figure IIH-104. FACT Semi-coherent, Run 112B, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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(C) Figure IIH-105. FACT Semi-coherent, Run 112B, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 112B, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Meters

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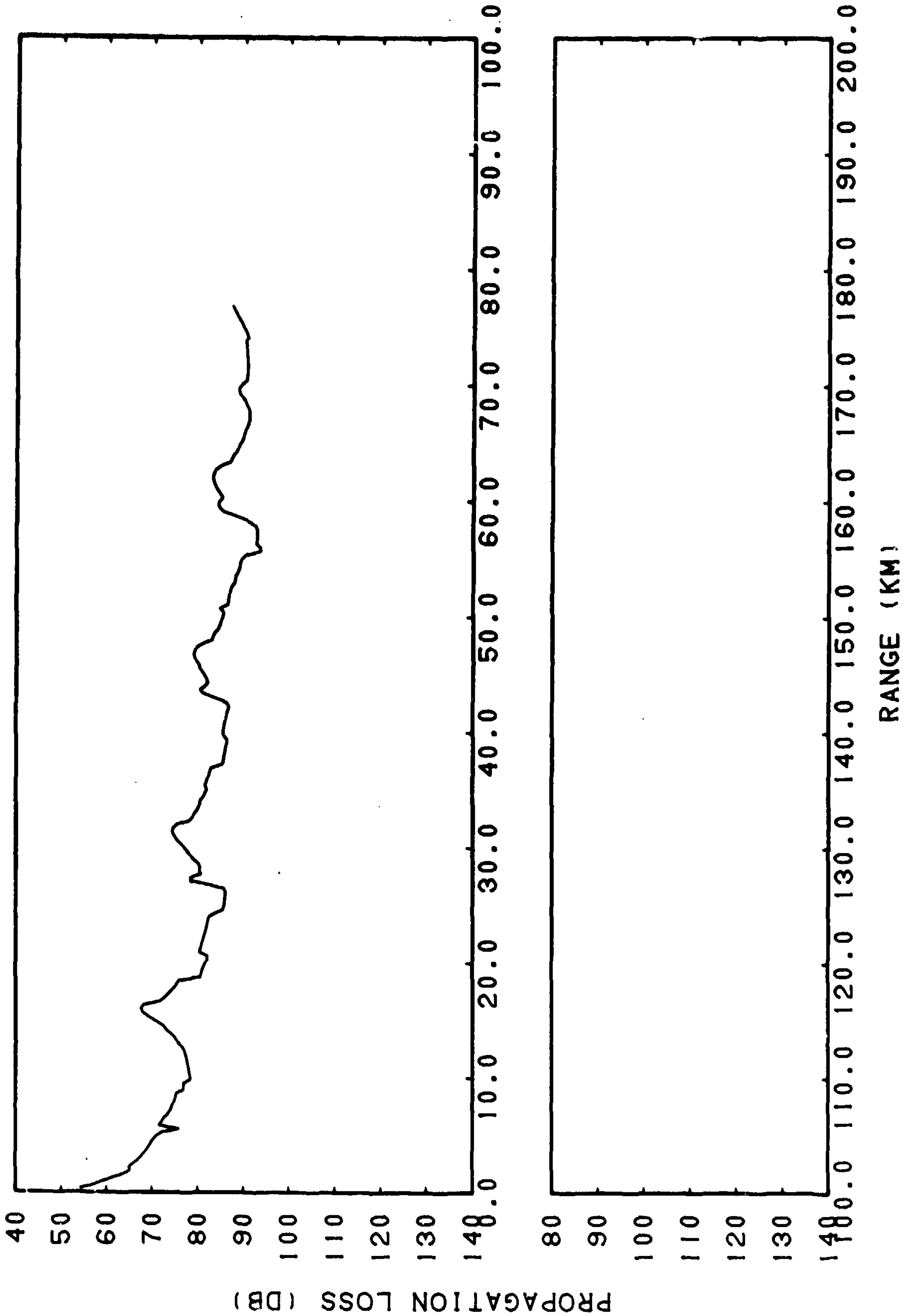

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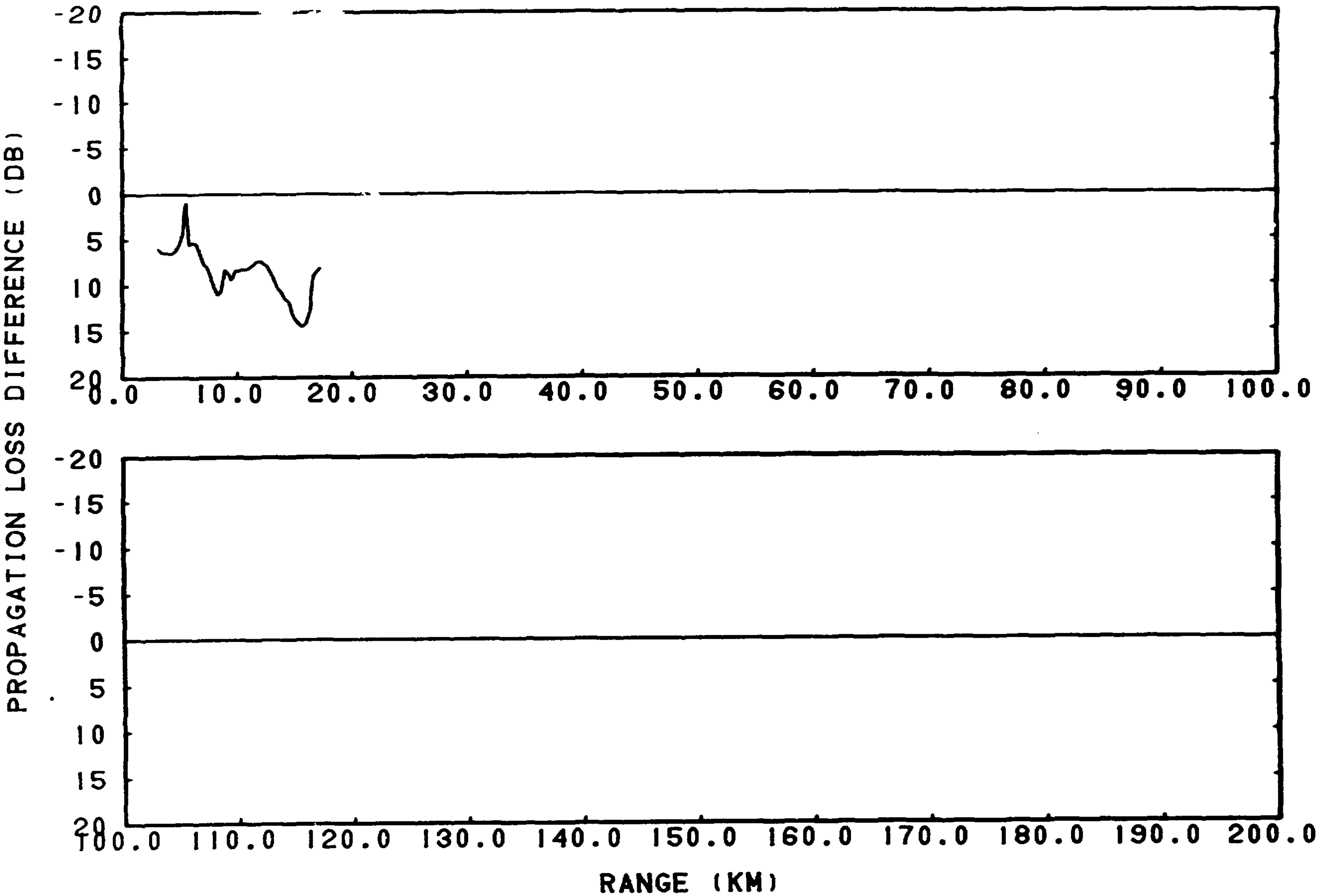
(C) Figure IIH-106. FACT Incoherent, Run 112B, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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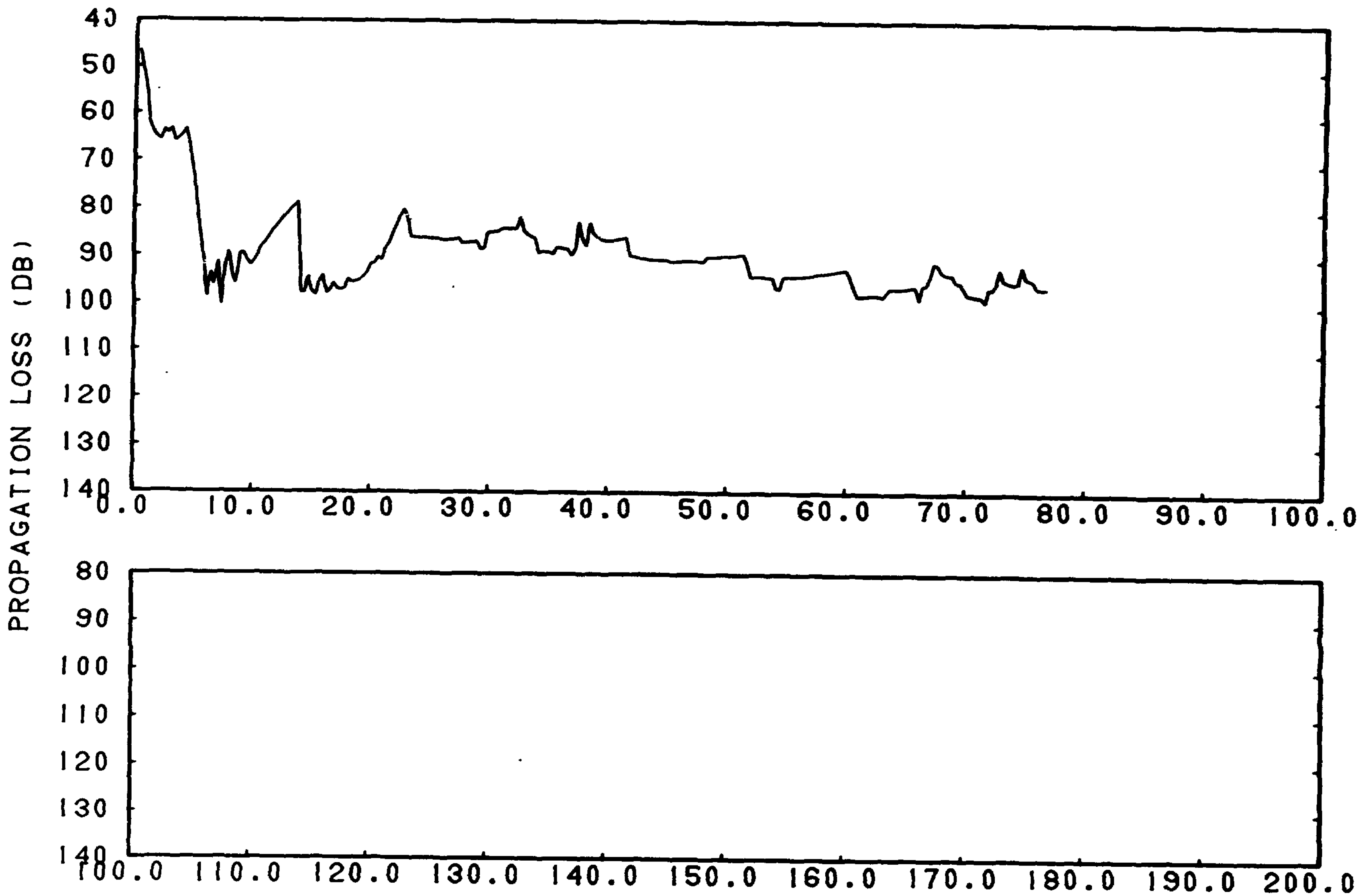
(C) Figure IIH-107. FACT Incoherent, Run 112B, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 112B, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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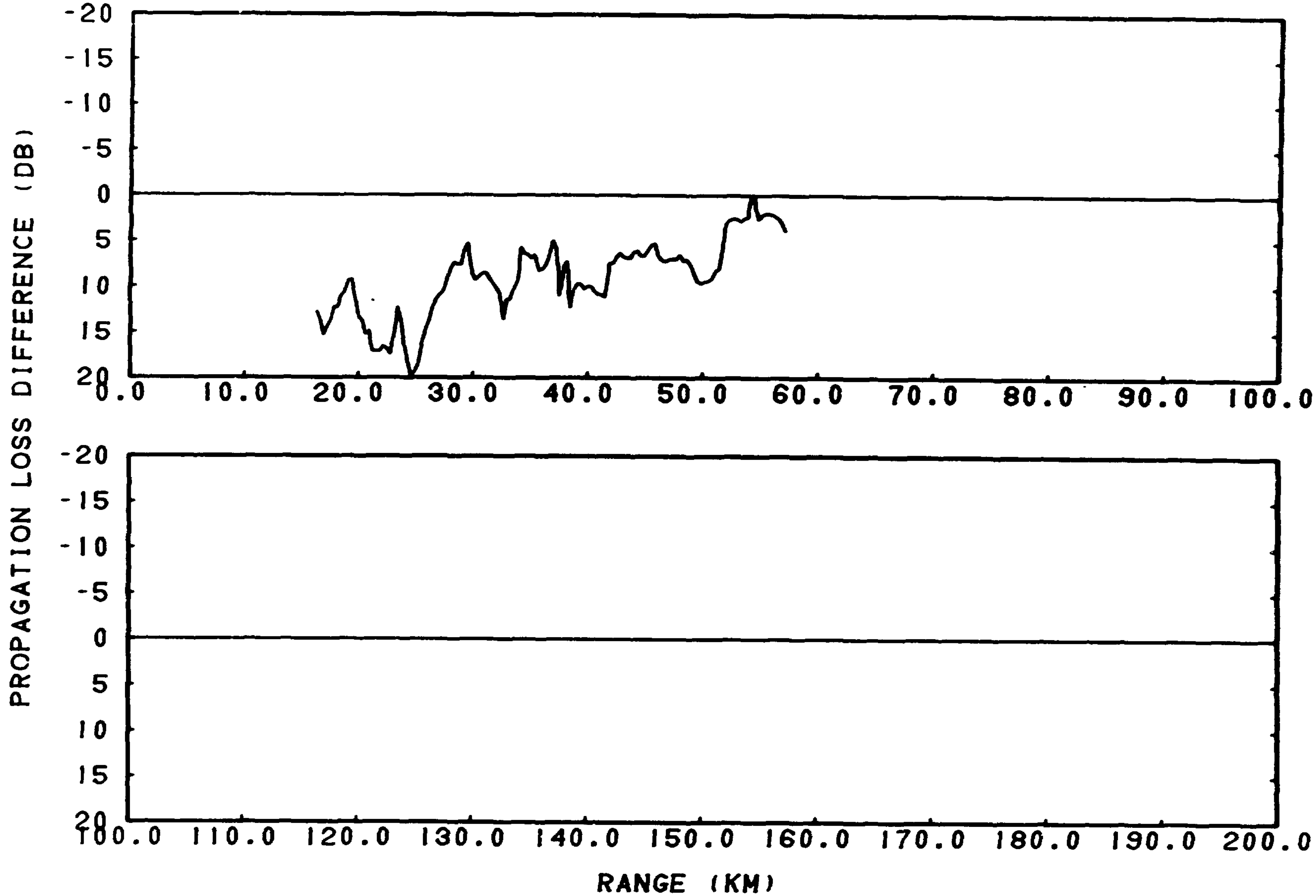
(C) Figure IIH-108. FACT Coherent, Run 112A, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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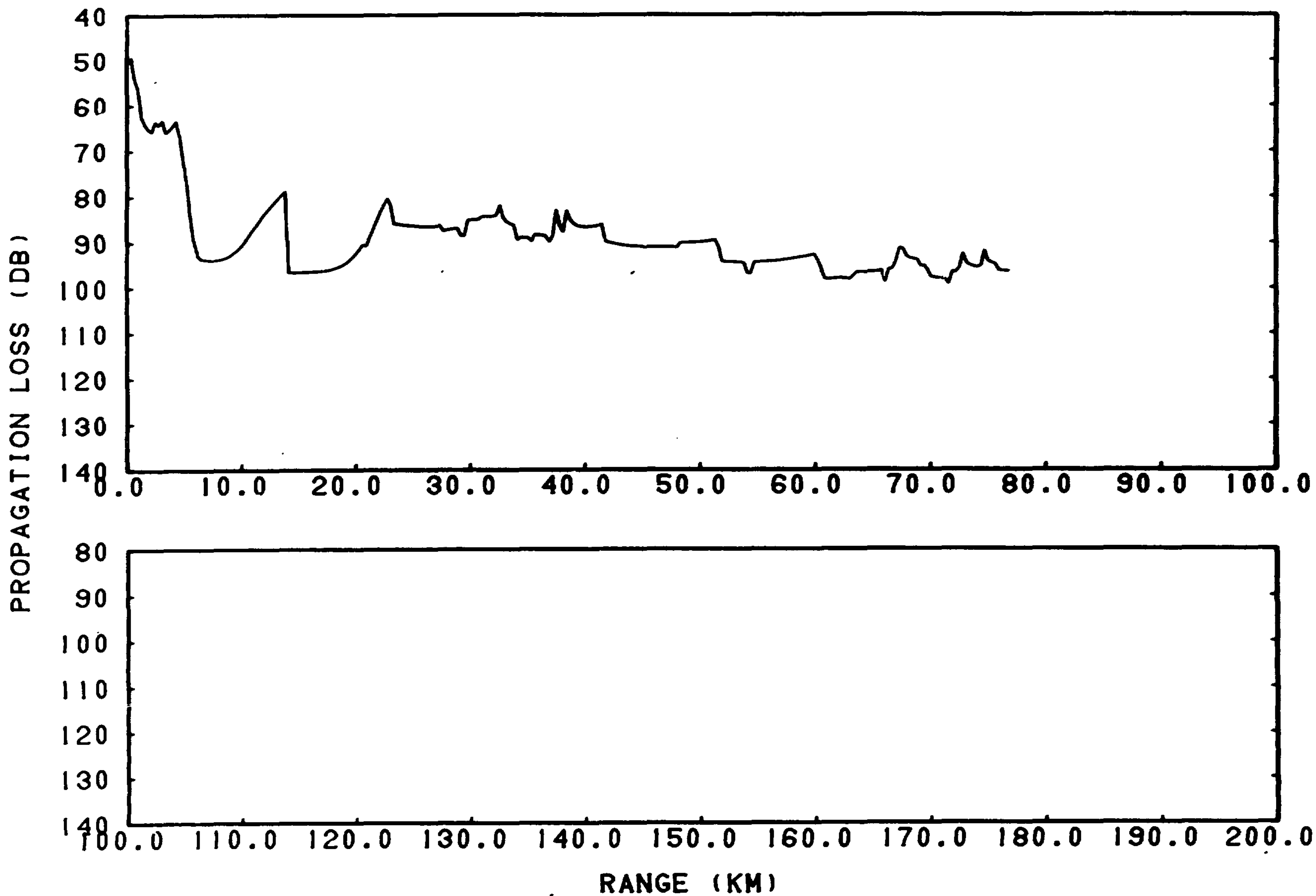
(C) Figure IIH-109. FACT Coherent, Run 112A, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 112A, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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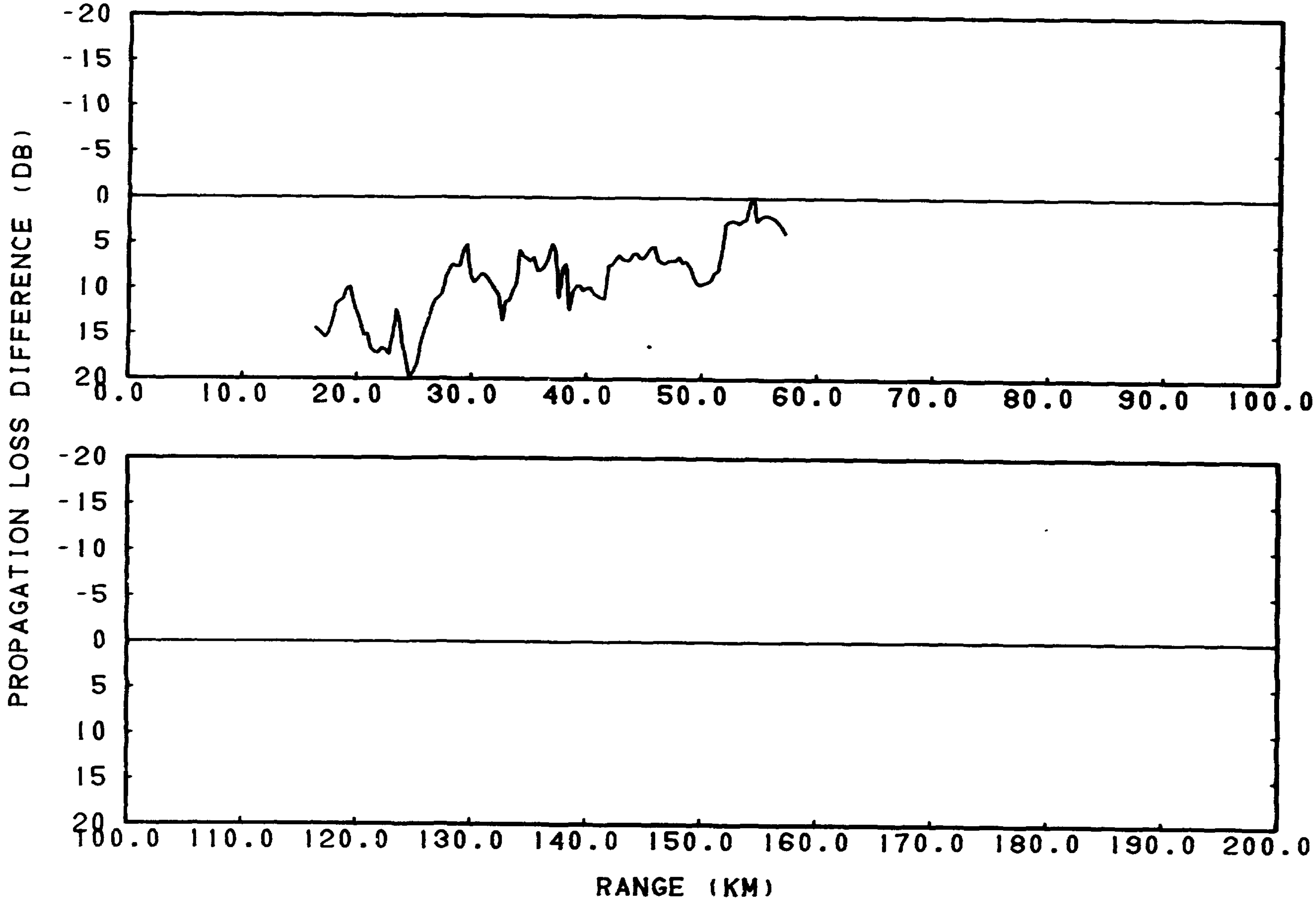
(C) Figure IIH-110. FACT Semi-coherent, Run 112A, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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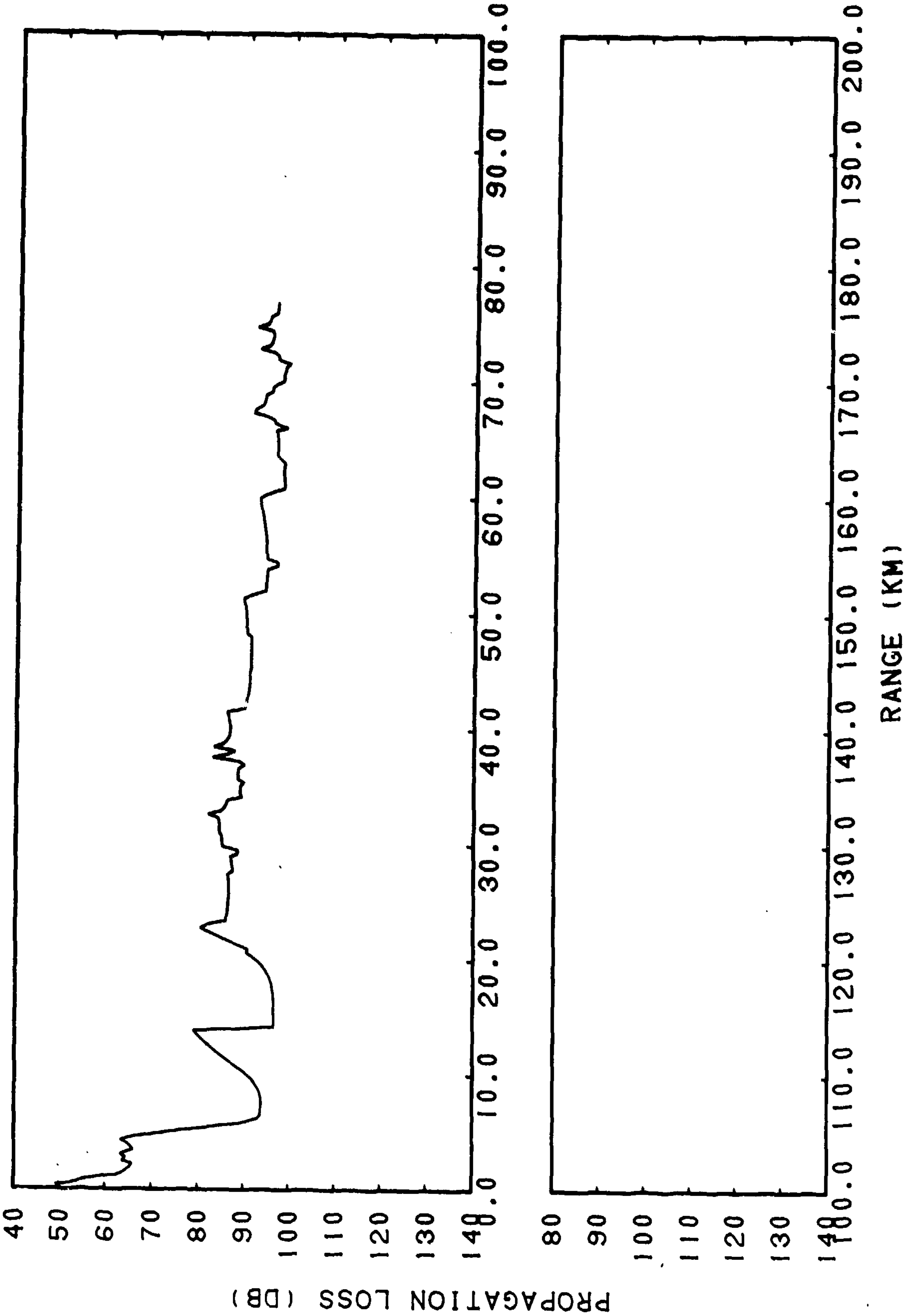
(C) Figure IIH-111. FACT Semi-coherent, Run 112A, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 112A, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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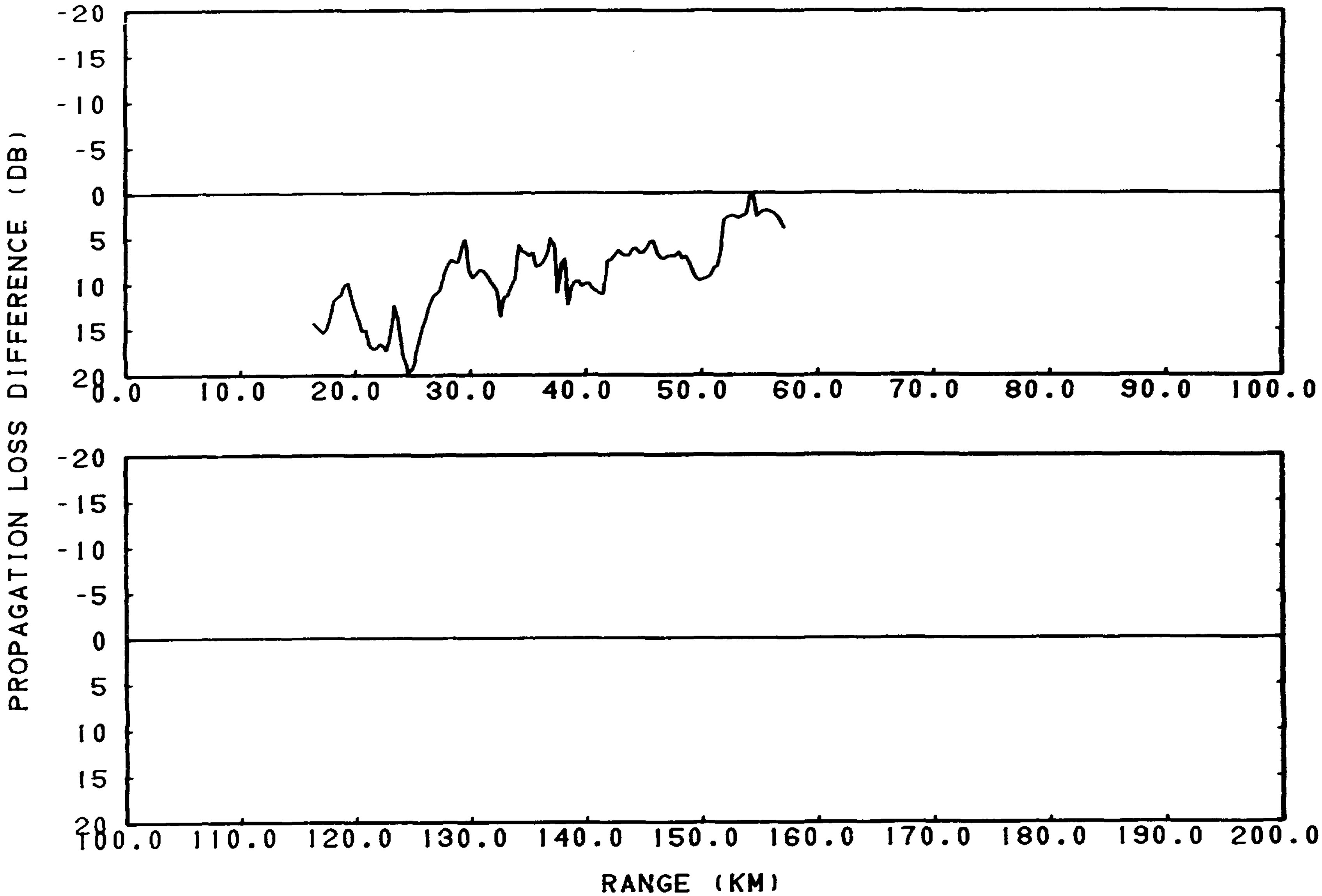
(C) Figure IIH-112. FACT Incoherent, Run 112A, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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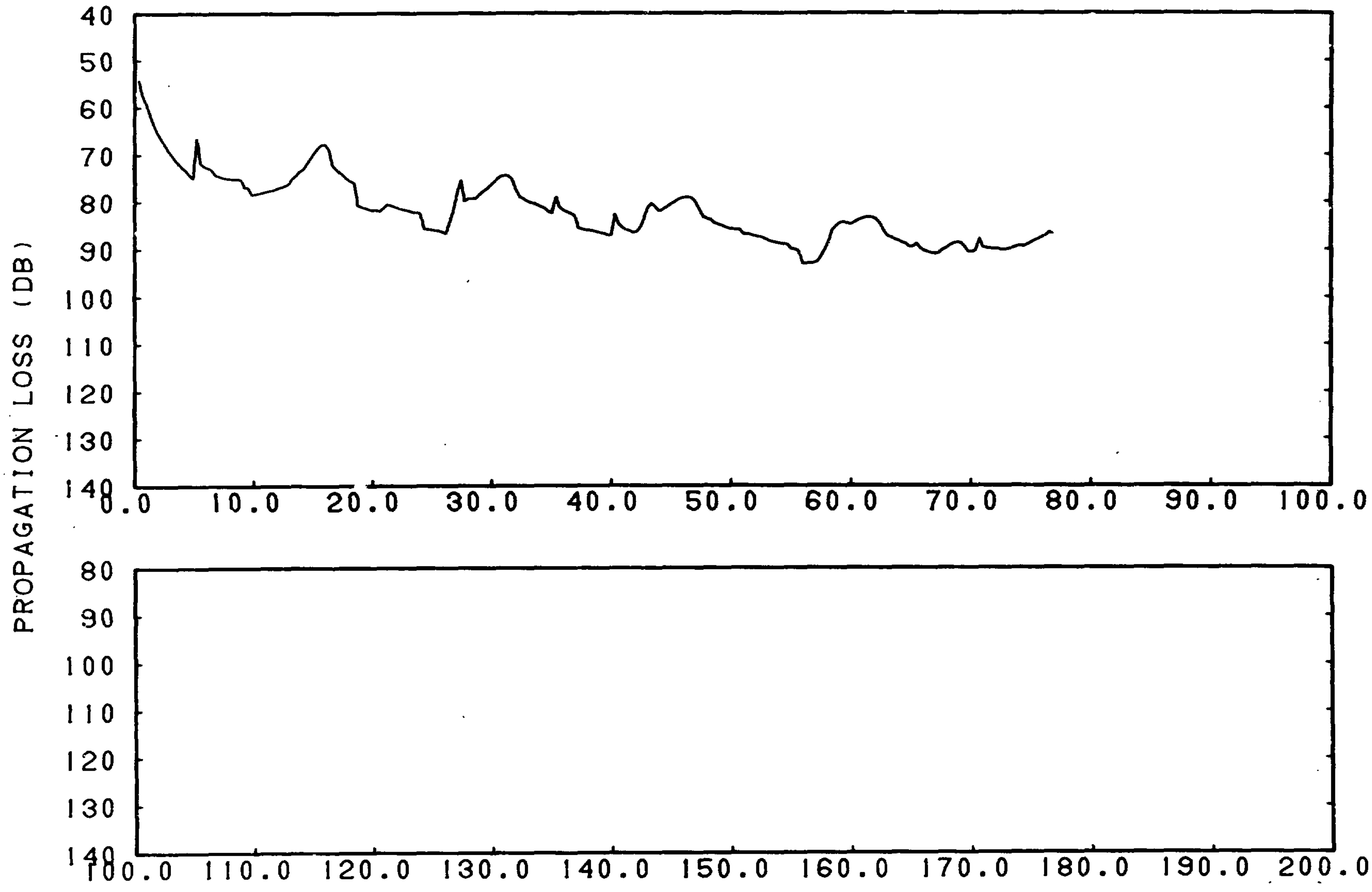
(C) Figure IIH-113. FACT Incoherent, Run 112A, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz, *Subtracted from Smoothed Gulf of* Alaska, Run 112A, Source Depth = 305 Meters, Receiver Depth = 30.5 Meters, Frequency = 2.5 Kilohertz



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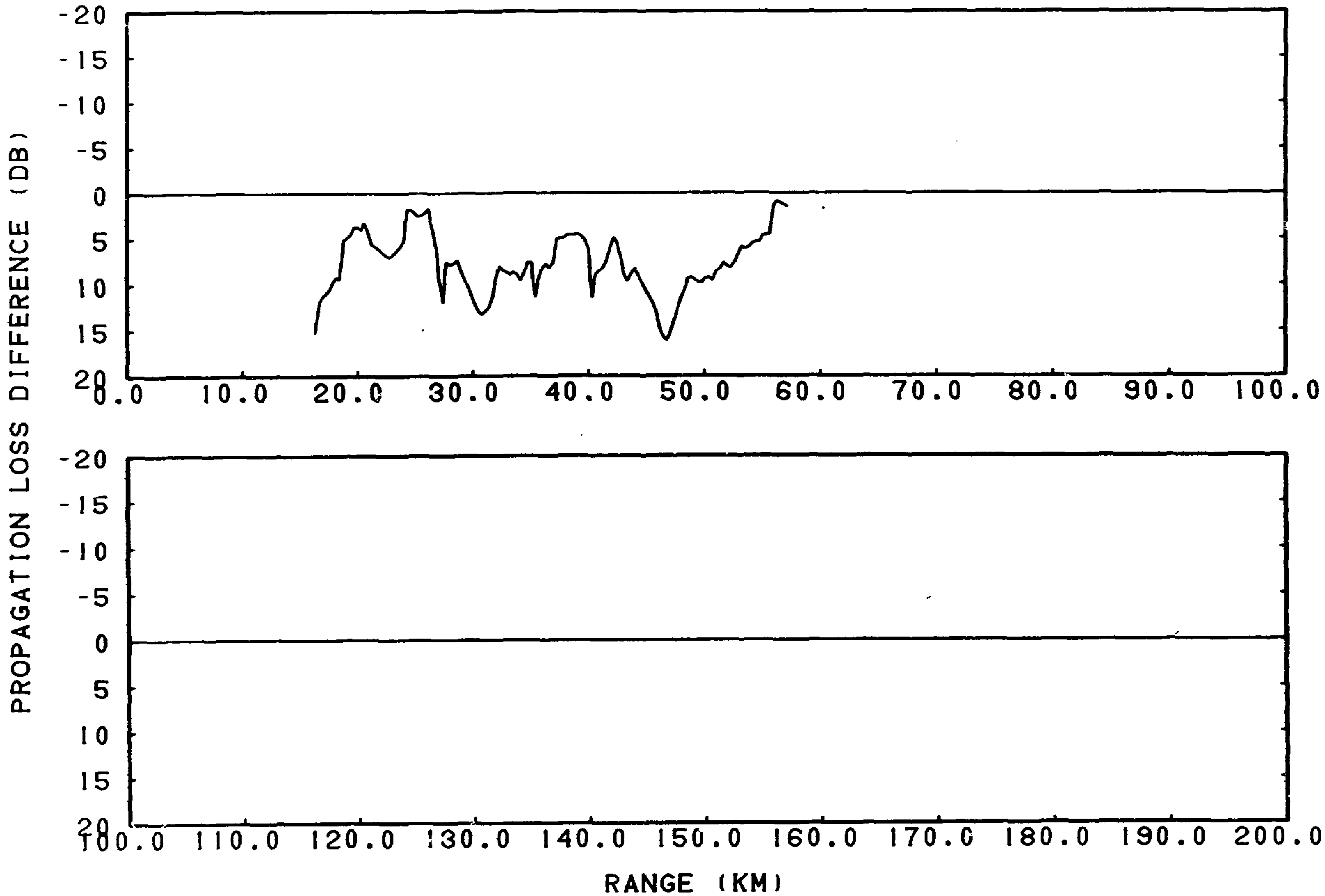
(C) Figure IIH-114. FACT Coherent, Run 112A, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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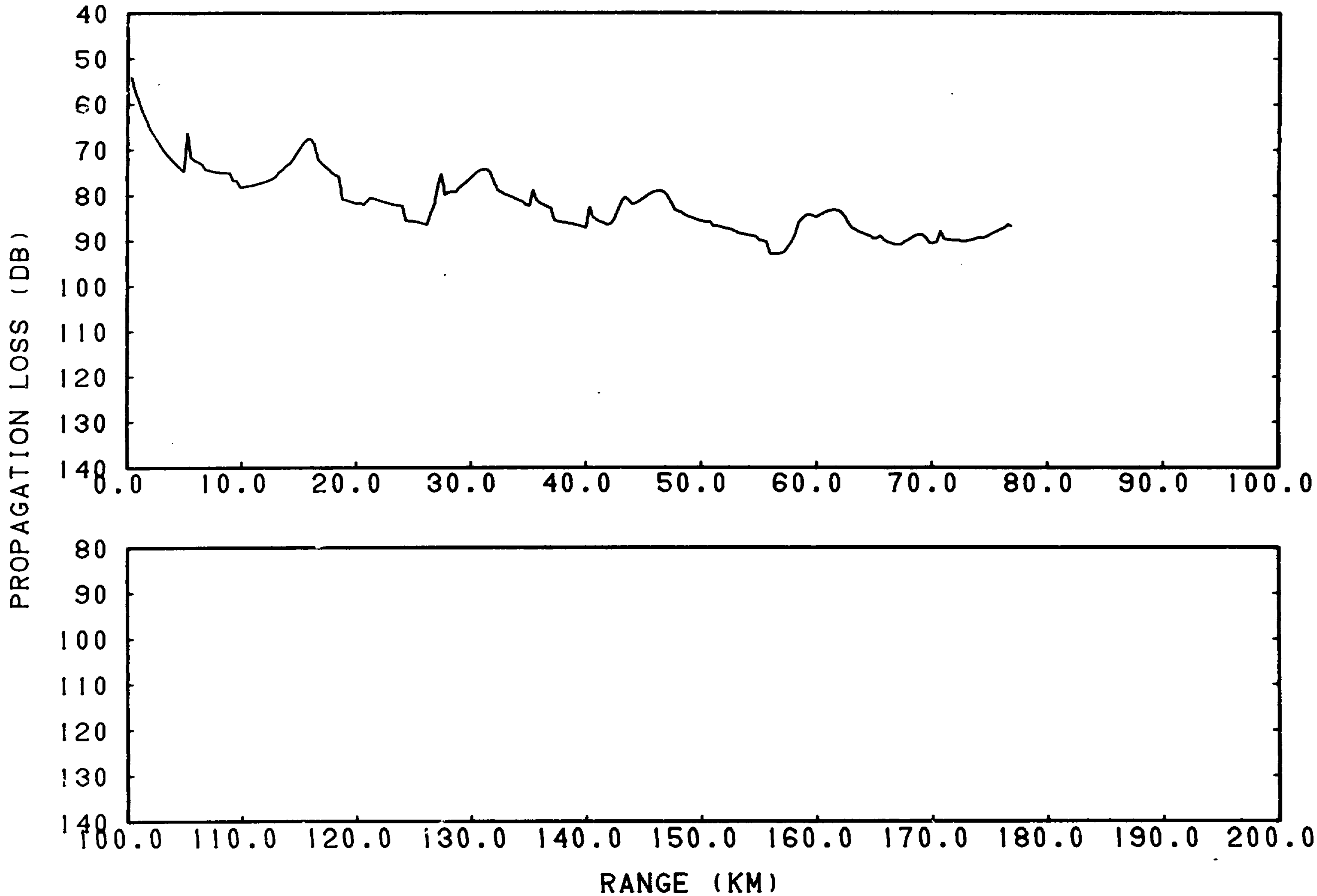
(C) Figure IIH-115. FACT Coherent, Run 112A, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 112A, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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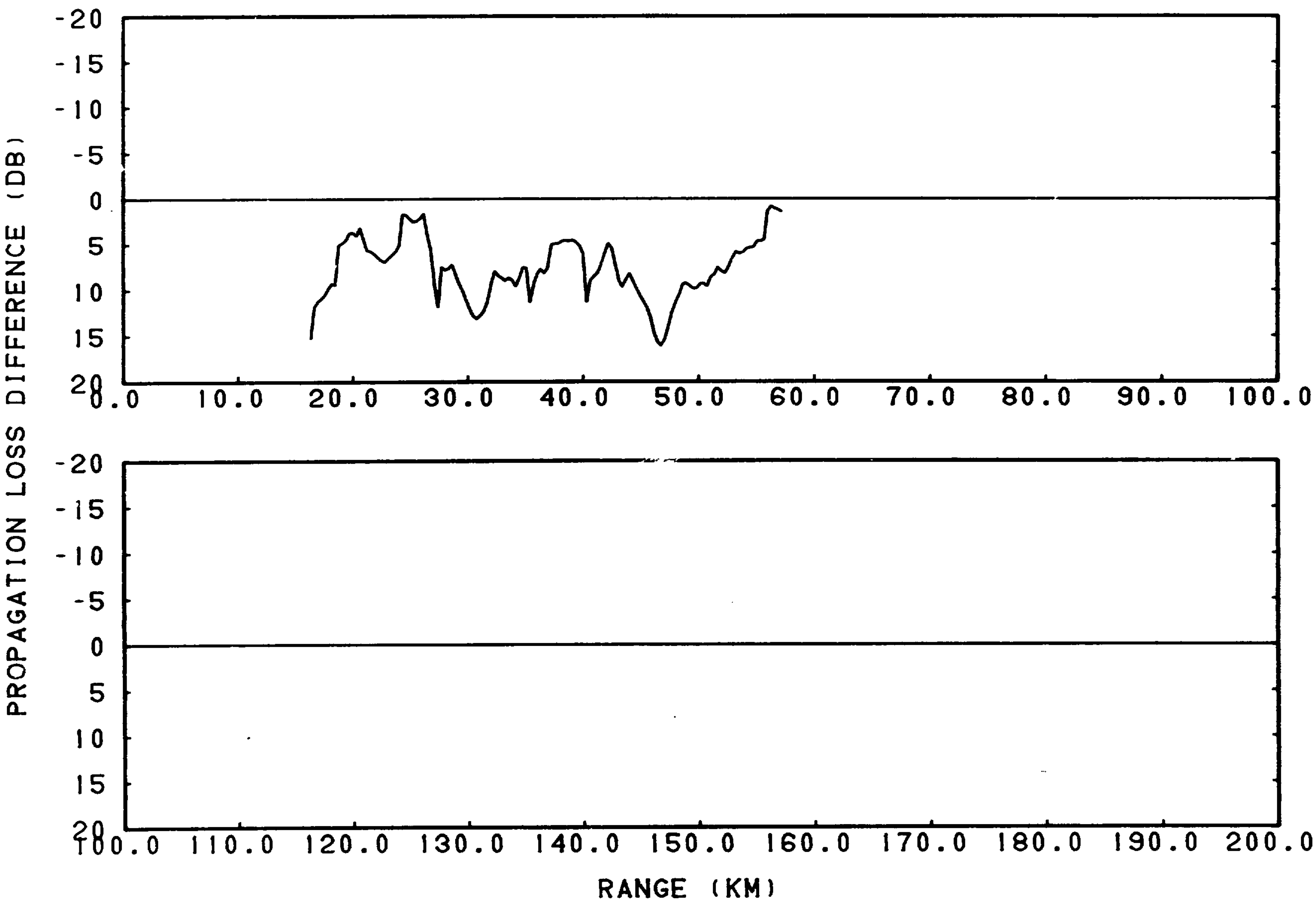
(U) Figure IIH-116. FACT Semi-coherent, Run 112A, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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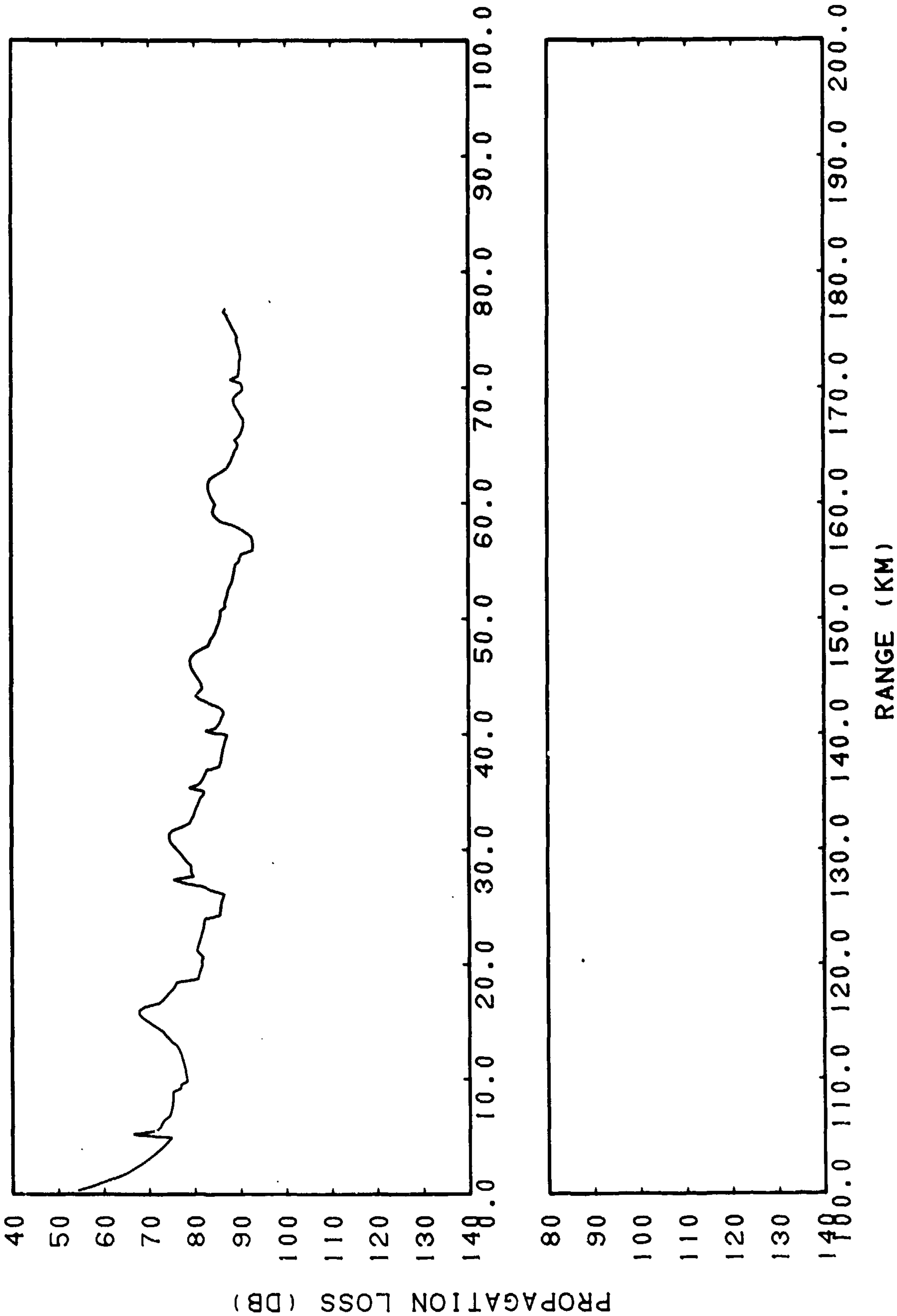
(C) Figure IIH-117. FACT Semi-coherent, Run 112A, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 112A, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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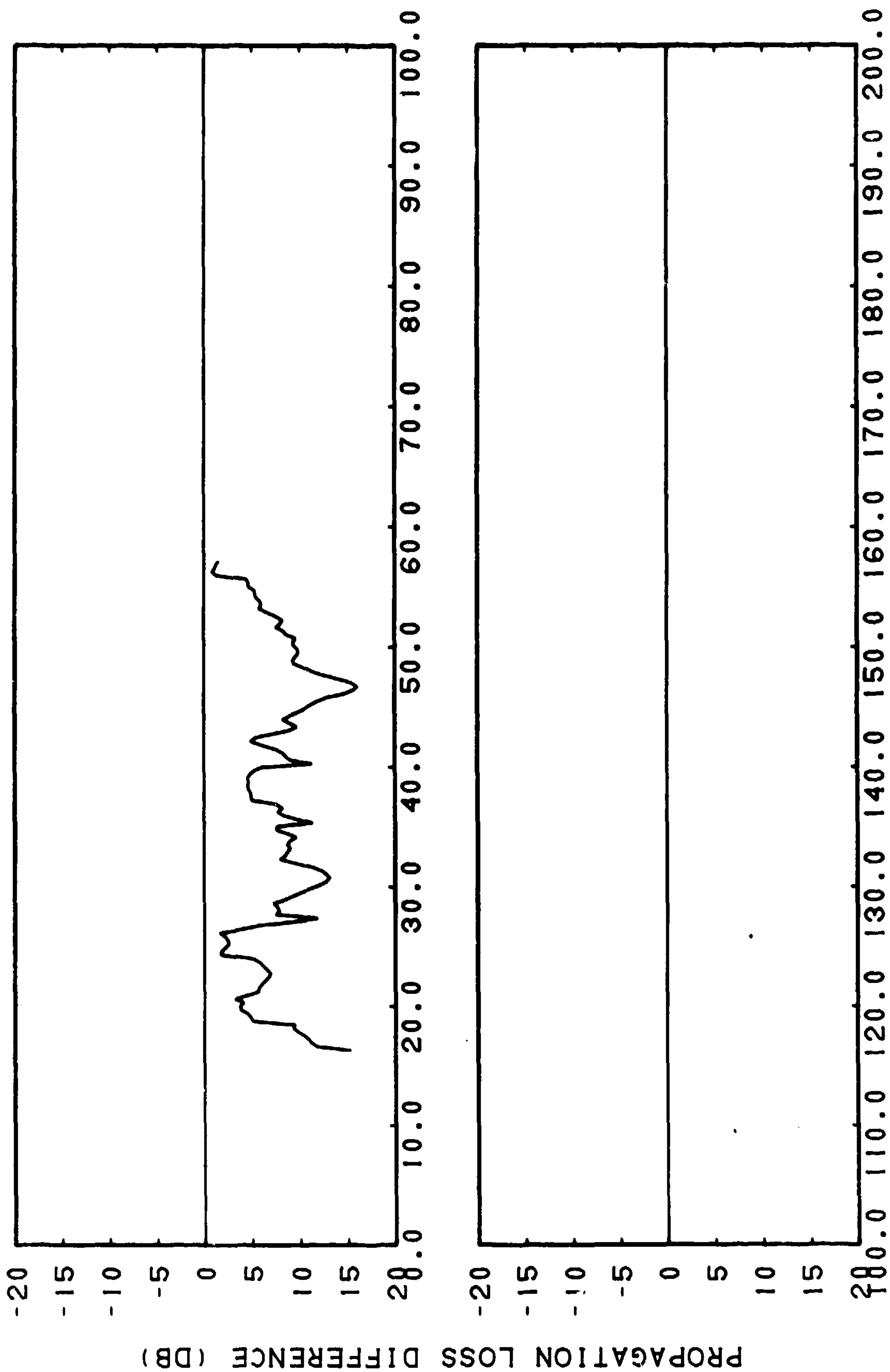
(C) Figure IIH-118. FACT Incoherent, Run 112A, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz



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(C) Figure IIH-119. FACT Incoherent, Run 112A, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz, Subtracted from Smoothed Gulf of Alaska, Run 112A, Source Depth = 305 Meters, Receiver Depth = 305 Meters, Frequency = 2.5 Kilohertz

DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH
800 NORTH QUINCY STREET
ARLINGTON, VA 22217-5660

IN REPLY REFER TO
5510/1
Ser 93/160
10 Mar 99

From: Chief of Naval Research
To: Commander, Naval Meteorology and Oceanography Command
1020 Balch Boulevard
Stennis Space Center MS 39529-5005

Subj: DECLASSIFICATION OF PARKA I AND PARKA II REPORTS

Ref: (a) CNMOC ltr 3140 Ser 5/110 of 12 Aug 97

Encl: (1) Listing of Known Classified PARKA Reports

1. In response to reference (a), the Chief of Naval Operations (N874) has reviewed a number of Pacific Acoustic Research Kaneohe-Alaska (PARKA) Experiment documents and has determined that all PARKA I and PARKA II reports may be declassified and marked as follows:

Classification changed to UNCLASSIFIED by authority of Chief of Naval Research letter Ser 93/160, 10 Mar 99.

DISTRIBUTION STATEMENT A: Approved for public release. Distribution is unlimited.

2. Enclosure (1) is a listing of known classified PARKA reports. The marking on those documents should be changed as noted in paragraph 1 above. When other PARKA I and PARKA II reports are identified, their markings should be changed and a copy of the title page and a notation of how many pages the document contained should be provided to Chief of Naval Research (ONR 93), 800 N. Quincy Street, Arlington, VA 22217-5660. This will enable me to maintain a master list of downgraded PARKA reports.

3. Questions may be directed to the undersigned on (703) 696-4619, DSN 426-4619.

Peggy Lambert

PEGGY LAMBERT
By direction

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The Acoustic Model Evaluation Committee (AMEC) Reports, Volume 2, The Evaluation of the Fact PL9D Transmission Loss Model, Book 3, Appendices E-H, September 1982, NORDA-35-VOL-2-BK-3, 428 pages
(DTIC # C034 020)

The Acoustic Model Evaluation Committee (AMEC) Reports, Volume 3, The Evaluation of the RAYMODE X Propagation Loss Model, Book 1, September 1982, NORDA-36-VOL-3-BK-1, 127 pages
(DTIC # C034 021)

The Acoustic Model Evaluation Committee (AMEC) Reports, Volume 3, TheEvaluation of the RAYMODE X Propagation Loss Model, Book 2, Appendices A-D, September 1982, NORDA-36-VOL-3-BK-2, 324 pages
(DTIC # C034 022)

The Acoustic Model Evaluation Committee (AMEC) Reports, Volume 3, The Evaluation of the RAYMODE X Propagation Loss Model, Book 3, Appendices E-H, September 1982, NORDA-36-VOL-3-BK-3, 388 pages
(DTIC # C034 023)